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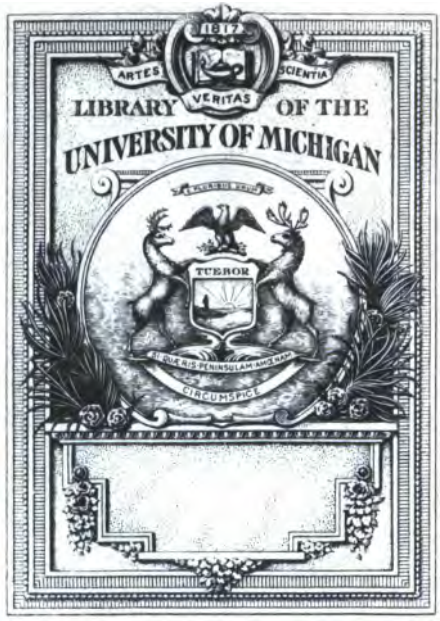

THE GIFT OF
C. B. Davis

Canada. Dept. of the Interior. Surveys branch.

MANUAL

SHEWING THE

SYSTEM OF SURVEY

OF THE

DOMINION LANDS,

WITH

INSTRUCTIONS TO SURVEYORS.

Published by authority of the Honourable the Minister of the Interior for Canada.

OTTAWA:
PRINTED BY MACLEAN, ROGER & CO., WELLINGTON STREET.
1883.

C 13 Davis
3-23-43

NOTICE TO DOMINION LAND SURVEYORS IN THE EMPLOYMENT OF THE DEPARTMENT OF THE INTERIOR.

This Manual and the instructions embodied in it are, by order of the Minister of the Interior, prescribed for the official guidance of Surveyors of the Dominion Lands of Canada, and they are required in making any survey of these Lands to govern themselves by it in every particular.

Its present edition is divided into two parts. The first treats of the system in which the Dominion Lands are laid out into Townships, gives instructions for the sub-divisional survey of these into the sections, quarter-sections and road allowances of which they are composed, and contains extracts from the Dominion Lands Act of clauses relative to Surveys and Surveyors.

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The second part gives instructions directed specially to surveyors of Standard Meridians and Parallels, and to those engaged in the survey of Township outlines.

The appendices consist of various forms to be used by the surveyors and of tables to facilitate their necessary calculations.

LINDSAY RUSSELL,
Surveyor-General.

Department of the Interior,
Ottawa, 1st June, 1883.

Note.—By desire of the Board of Examiners for Dominion Land Surveyors, candidates for admission to the practice of the profession, are informed that only the first part of the Manual will be required at the examination.

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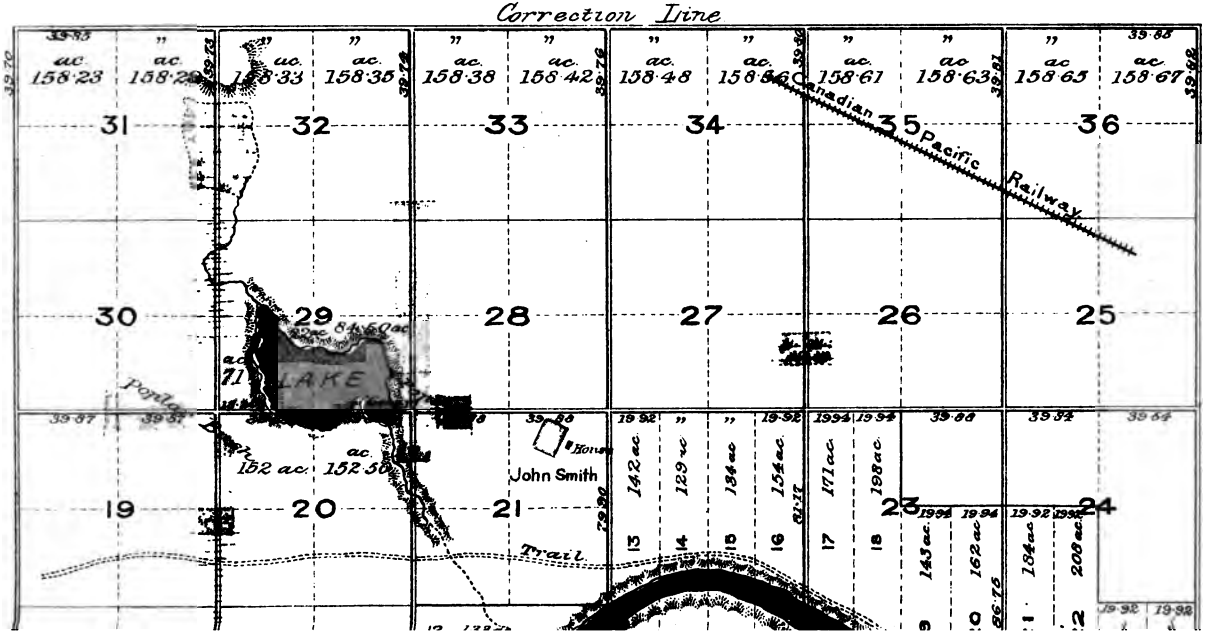
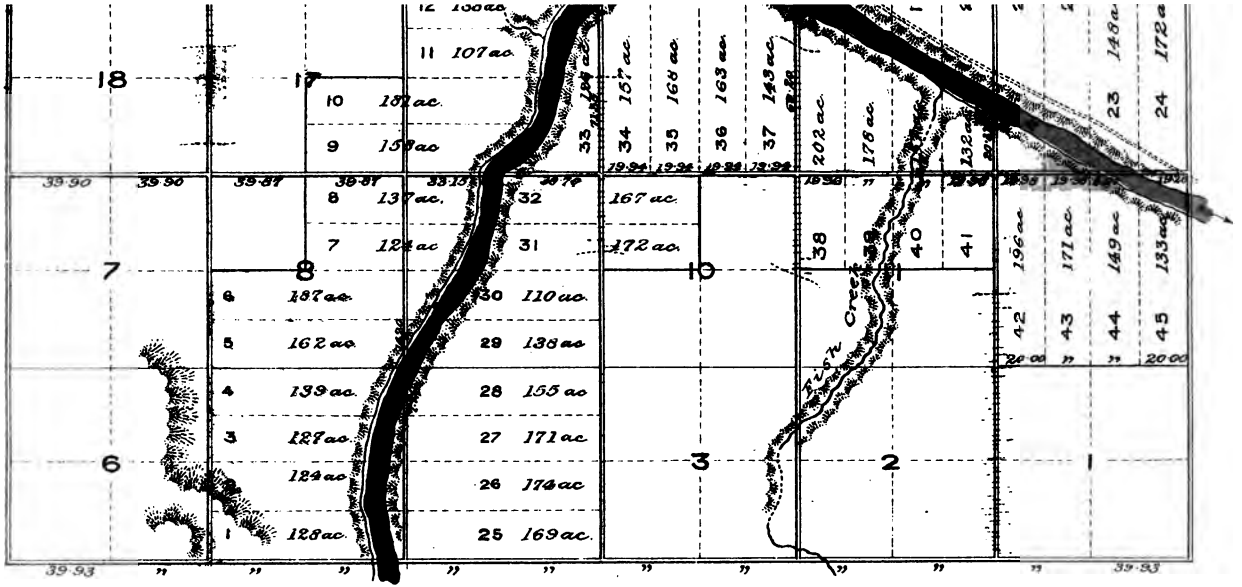




Surveyed by the Undersigned

Thomas Anderson

June and July, 1883.

Dominion Lands Office
Ottawa.

..... 188 ..

Approved and confirmed.

Surveyor General.

Contents.

Land in Sections	22368·10 Acres
Roads	433·60 "
Water	653·50 "
Total Area	23,455·20 "

SYSTEM OF SURVEY

AND

INSTRUCTIONS

TO

SURVEYORS

ACTUAL SYSTEM OF SURVEY.

Township contains thirty-six square miles, more or less, exclusive of road allowance.

1. The Dominion lands are laid off in quadrilateral townships containing thirty-six sections of six hundred and forty acres or one square mile in each, subject to the deficiency or surplus from the convergence or divergence of meridians, as hereinafter mentioned, together with road allowances of one chain on every section line running north and south and on every alternate section line running east and west.

Sections.

2. The sections are bounded and numbered as shown by the following Diagram.

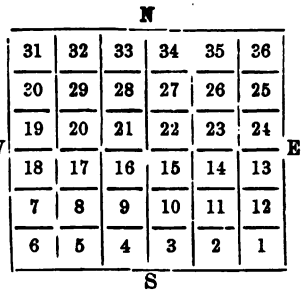


Fig. 1.

Townships measure 483 chains on east and west sides, and 486 on north and south sides.

3. The township, therefore, measures on the east and west sides, from centre to centre of the road allowances bounding the same, four hundred and eighty-three chains, and on the north and south sides four hundred and eighty-six chains, subject to the deficiency or surplus from converging or diverging meridians, as the case may be.

Lines bounding townships

4. The lines bounding townships on the east and west sides are true meridians, and those on the north and south sides are chords of the parallels of latitude passing through the corners of the township.

Lines bounding sections

5. The lines bounding sections on the east and west sides are true meridians, and those on the north and south sides are lines parallel to the north and south boundaries of the township.

How townships are numbered.

6. The townships number in regular order, northerly from the International Boundary or fifty-ninth parallel of latitude, and lie in ranges and are numbered east and west from a meridian line styled the Principal Meridian; ranges lie also and are numbered west from other meridians styled the Second, Third.....Initial Meridians, according to their order westward from the Principal Meridian.

A few townships east of the Principal Meridian, lie south of the forty-ninth parallel and are numbered accordingly.

How to designate a "gore" near the line between two different systems of survey.

7. Whenever a "*gore*" occurs between two adjoining townships or ranges surveyed according to different systems, and when the number of the fractional township or range is the same as the number of the adjoining one surveyed under the former system, such township or range is designated by its number, followed by the letter A, as for instance:

Tp. 19, A,

For the gore between townships 18 and 19 west of the Second Principal Meridian, and

Range 21, A,

For the gore between ranges 20 and 21 west of the Second Principal Meridian.

The line between two parts of the country surveyed according to different systems is established as a correction line, that is to say, posts are planted on both sides of the road allowance on such line, each row governing the position of the boundary lines on its own side. Such road allowance is in all cases, one chain and fifty links wide.

Sections are 80 chains on base lines.

8. The sections are laid out of the precise width eighty chains, as aforesaid, or eighty-one chains with the road allowance, on certain lines called "*base lines*," and the meridians between the sections are drawn from such bases, north or south, to the depth of two townships, that

is to say, to the correction lines hereinafter mentioned. The sections south of the base measure therefore more than eighty chains, while they measure less north of the same line. The interval between a base line and the next one is equal to the depth of four townships.

"Jog" allowed on correction lines.

9. The "*correction lines*" are those upon which the "*jog*" resulting from the want of parallelism of meridians, is allowed, or, in other words, they are those township lines running east and west which are equi-distant from the bases at the depth of two townships. The interval between the correction lines is equal to the depth of four townships.

Base lines in the system.

10. The first base line is the forty-ninth parallel of latitude or International Boundary; the second base is between townships four and five; the third between townships eight and nine; the fourth between townships twelve and thirteen; the fifth between townships sixteen and seventeen, and so on northerly, in regular succession.

Correction lines in the system.

11. The first correction line is between townships two and three; the second between townships six and seven; the third between townships ten and eleven, and so on, northerly, in regular succession.

Division of sections.

12. Each section is divided into quarter sections of one hundred and sixty acres, or one-half mile square, more or less.

Lands on the Saskatchewan and other rivers to be laid out in River lots.

13. The lands adjoining the Saskatchewan Battle, Bow, Red Deer and Belly Rivers are laid out in lots twenty chains wide, fronting on the river, and about one mile deep. The side lines are parallel to the section lines.

The lots are numbered down stream, from one upwards, separately in each township, commencing on the left bank first, then on the right bank.

Country laid out into blocks of sixteen townships each, in the first instance and how.

14. Preliminary to the sub-division into townships and sections of any given portion of country proposed to be laid out for settlement, the same is laid out into blocks of sixteen townships each, by projecting the base lines and the east and west meridian boundaries of each block.

Blocks subdivided into townships and how.

15. Such blocks are sub-divided into townships by projecting the meridians from the base lines to the correction line, and connecting by straight lines the township corners on the meridians.

Allowance for the discrepancies of the survey.

16. In the survey of any block or its subdivision, the closing errors on the correction line are allowed for in the quarter-sections north and south of and adjoining the correction line.

Corners.

17. On the block and township outlines, at the time of the survey, all townships, section and quarter section corners are marked, which corners govern respectively in the subsequent sub-division of the block or township.

Posts and monuments.

18. Only a single row of posts or monuments to indicate the corners of the township or sections (except as hereinafter provided) is placed on any survey line. These posts and monuments, as an invariable rule (with the exception above referred to) are placed in the west limit of the road allowances on north and south lines, and in the south limit of road allowances or on the line between the sections, on east and west lines; and in all cases fix and govern the positions of the boundary corners of the adjoining townships, sections or quarter-sections on the opposite side of the road allowance.

Posts and monuments on correction lines.

19. The township, section or quarter-section corners on correction lines or on lines between differen systems of surveys are in all cases indicated by posts or monuments planted and marked independently for the townships on either side; those for the townships north or east of the line, in the north or east limit of theroad allowance, and those for the townships south or west, in the south or west limit. Indian reserve boundaries are also posted on both sides of the road allowance; on one side for the reserve and on the other side for the township.

Quarter-quarter sections.

20. To facilitate the descriptions for letters patent of less than a quarter-section, the quarter-sections composing every section in accordance with the boundaries of the same as planted or placed in the original survey, are supposed to be divided into quarter quarter-sections, or forty acres, and such quarter quarter-sections are numbered as shown in the following diagram.

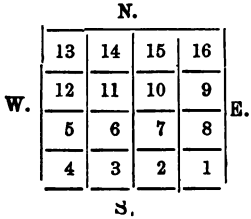


Fig. 2.

DIAGRAM

Illustrating the subdivision of the country into blocks and townships.

Ranges West of the Third
Initial Meridian
Ranges West of the Second
Initial Meridian.
Fourth Base Line
Fourth Correction Line
Third Correction Line
Tp. 10
Third Base Line
Second Correction Line
Tp. 5
Second Base Line
First Correction Line
First Base Line
INTERNATIONAL BOUNDARY.
XII XI R.X IX VIII VII VI R.V IV III II R.I XXIX XXVIII XXVII XXVI R.XXV XXIV XXIII XXII
13 12 11 10 9 8 7 6 5 4 3 2 1
DOMINION LANDS LITHOGRAPHIC OFFICE.

Legal sub-divisions of townships.

21. Legal sub-divisions as applicable to the survey, sale and granting of the Dominion lands, are as follows:—

A section or 640 acres;
A half-section or 320 acres;
A quarter-section or 160 acres;
A half quarter-section or 80 acres;
A quarter quarter-section or 40 acres.

Surveys performed by contract.

22. The township sub-division surveys of the Dominion lands, according to the system above described, are carried out and performed by contract at a certain rate per mile or per acre, fixed from time to time by the Governor in Council.

FIRST SYSTEM OF SURVEY.

Road allowances.

23. In the first system of survey, there is a road allowance of one chain and fifty links on every section line.

Townships measure 489 chains on each side, more or less.

24. The township, therefore, measures on each side from centre to centre of the road allowance, bounding the same, four hundred and eighty-nine chains, subject to the deficiency or surplus resulting from converging or diverging meridians.

Closing errors left in the western range of quarter sections.

25. In the survey of a township the deficiency or surplus resulting from converging or diverging meridians is set out and allowed in the range of quarter-sections adjoining the western boundary of the township. It follows that generally the lines bounding sections on the east or west sides are not meridians, but lines parallel to the eastern boundary of the township. All quarter-section sides are exactly forty chains, except in the western range of quarter-sections of a township and in the sections adjoining a correction line and subject to the discrepancies of the survey.

Other rules the same as in actual system of survey.

26. Where not provided otherwise above, the rules laid down for the actual system of survey govern for the firstsystem.

Area surveyed under the first system.

27. The operation of the first system of survey is restricted to the area bounded as follows, viz:

To the south, by the International Boundary line, to the west by the Second Initial Meridian, as far as the eighth correction line; by said correction line as far as the meridian between ranges twenty-eight and twenty-nine west of the Principal Meridian; by said meridian between ranges twenty-eight and twenty-nine, as far as the seventh correction line; by said correction line as far as the meridian between ranges four and five, west of the Principal Meridian; by said meridian, between ranges four and five, as far as the sixth correction line; by said correction line, as far as the meridian between ranges ten and eleven east of the Principal Meridian; by said meridian, between ranges ten and eleven, as far as the third correction line; by said correction line, as far as the meridian between ranges thirty and thirty-one, east of the Principal Meridian; by said meridian, between ranges thirty and thirty-one, as far as the International Boundary line.

Also Township 44, R. 21; Tp. 45, R. 21, 22, 27, 28; Tps. 46 and 47, R. 25, 26, 27, and 28; Tp. 48, R. 24 and 25, west of the Second Initial Meridian.

Townships 42 to 47 inclusive, R. 1; and Tps. 43 and 44, R. 2 and 3, west of the Third Initial Meridian.

SECOND SYSTEM OF SURVEY.

Deficiency or surplus from converging or diverging meridians divided equally between all quarter sections.

28. The second system of survey is similar in all respects to the first system, except in regard to the deficiency or surplus from converging or diverging meridians which is distributed equally between all quarter-sections as in the actual system.

Area surveyed under the second system of survey.

29. The operation of the second system of survey is restricted to Tps. 1 and 2, R. 1 to 8 inclusive; Tps. 19 to 30, R. 1 to 12 inclusive; and Tps. 27 to 30, R. 13 to 16 inclusive; the above ranges being all west of the Second Principal Meridian.

FIELD WORK.

Surveys to be astronomical

30. The surveys of the Dominion lands are to be astronomical; that is to say, the directions of their lines must be referred to the astronomical meridian. The use of the magnetic needle on Dominion Land surveys is forbidden.

Chain to be used.

31. All measurements shall be made with the ordinary four pole, or Gunter's chain. It is to be tested and corrected, during use, by a standard measure which shall have been previously compared with the standard at the Dominion Lands Office. If going through Winnipeg, or any other point where a standard section may have been established, the surveyor will train his chainmen there until they can chain correctly. Eleven pins should be used, so as to leave one in the ground when exchanging tallies. The number of chains at any point is then equal to the number of pins, minus one.

Chainmen to be sworn.

32. Previous to entering on their duties the chainmen shall be sworn according to the form below and such oath shall be filed with the returns of the survey.

(*Form of Oath.*)

I, A. B., do solemnly swear that I will faithfully discharge the duties of a chainman to the best of my ability and knowledge. So help me God.

(Signed) A. B.

Sworn before me at this day of 188 } .....C.D. .....D.L.S.

Precautions in chaining over broken ground.

33. In chaining over uneven ground, should the same be so broken as not to permit of the full chain being levelled, the measurement should be made with such portion thereof as may be easily levelled, and particular care should be taken at such

times, in plumbing and dropping the pins, in order to obtain the accurate horizontal measurement.

Obstacles on the line.

34. In case the survey line be obstructed by a lake, pond, deep marsh or other obstacle, the surveyor will pass it by right-angled offsets, or, if more convenient, by a trigonometrical operation. The angle opposite to the base should be, whenever practicable, at least thirty degrees. It shall never be less than fifteen degrees.

Blazing

35. Surveyors will understand that all lines through woodland are to be well opened out, those connecting the posts are to be marked by blazing the adjacent trees on each of the sides in the direction which the line is being run as well as the side on which the line passes.

No blaze on traverse lines.

36. No blazes or marks of any description are to be made on traverse lines between the points on township or section lines which intersect the same.

Blazed lines not required to be perfectly straight.

37. The Dominion Lands Law does not recognize a blazed line as a legal boundary; therefore, it is not necessary that any such line be a perfectly straight one, but it should never differ very much from it. When running a trial line in the woods, the surveyor, instead of opening the true line, may connect the trial line with the posts by short lines. The angles formed by the latter and the trial line should, however, not be too large, say not over 5°. The blazed line must pass through all the posts.

Instructions to be strictly followed.

38. The instructions contained in the manual are to be strictly followed even when there appears to be evident advantage to depart therefrom. Errors in the lines previously surveyed, or any other reason, would not justify a departure therefrom.

Surveys under different systems to be distinct.

39. When a survey made on the new system adjoins townships of the old system, the lines of the new system are to be run as if the lines enclosing the area surveyed under the old system were the shores of a lake, and no line of the old system is to be produced into the new one.

Road allowance to be left between different systems.

40. A road allowance of a chain and a-half is to be left between the tracts covered by different systems of survey.

Road allowance to be left on Indian Reserve Boundaries.

41. A road allowance is to be left on the boundaries of all Indian reserves. When a reserve not yet surveyed, is to be formed of a certain number of full sections, the surveyor, in establishing the same shall plant the posts as usual on the west and south boundaries; but on the north and east side they are to be planted in the north or east limit of the road allowance. The side of the road allowance adjoining the townships is the only one to be posted by the surveyors employed by the Department of the Interior.

BOUNDARY CORNERS.

42. Having ascertained by exact running and measurement the proper point for establishing the township, section or quarter-section corner, as the case may be, the surveyor, in marking the same, is to be governed by the following directions:—

Township corner on a prairie spot.

43. On a prairie spot, a township corner is marked by a pointed iron tube five feet long and $1\frac{3}{8}$ inches in diameter. It is driven perpendicularly with a sledge to within ten inches from the top; and the appropriate marks and numbers, as hereinafter directed, are cut thereon with a cold chisel. A mound of earth is erected as hereinafter described.

Township corner on a timbered spot.

44. In a timbered country the corner of a township is also marked by an iron tube as above, but no mound is built.

Bearing trees

45. The position of the post is defined by ascertaining the astronomical bearing and distance therefrom of one or more adjacent trees, which tree or trees are to be marked B.T. with a knife or scribing iron on the side next the post, the distance and bearing being marked with red chalk or paint. The size and description of the tree as well as the bearing and distance are to be duly entered in the field notes.

Section corner on a prairie spot.

46. A section corner in prairie is to be marked by an iron tube 3 feet 8 inches in length, planted in the centre of a mound as hereinafter described. The post is driven one foot into the ground and shows two inches above the mound.

The numbers of sections, township and range are stamped on a square plate of tin held on top of the post by a nail passing through a hole in the post or by some other means. The

letters N.S.E. and W. are marked at the four corners of the plate to show its proper position.

Section corner on a timbered spot

47. On a timbered spot, a section corner is marked by a wooden post, the position of which is defined by reference to bearing trees.

Such posts should be at least three inches square, two feet above and twelve inches below the surface of the ground.

Quarter section corner on a prairie spot.

48. A quarter-section corner is marked, in prairie, by a wooden post planted in the centre of a mound as hereinafter described, such post to be four feet four inches long, so as to be twelve inches in the ground, two feet six inches in the mound, and ten inches above. It is flattened on two sides and marked with the fraction $\frac{1}{4}$ (fraction wise) to identify it as a quarter-section post. The flattened sides should be at least three inches wide and placed at right angles to the direction the line is being run.

When wood for posts is not to be found within three miles from the site of a quarter-section corner, such corner may be indicated simply by a mound.

Quarter section corner on a timbered spot.

49. In the woods, a quarter section corner is marked by a wooden post, flattened and marked on two sides as above, and at least eighteen inches above and twelve inches below the ground.

Boundaries of line between river lots.

50. A boundary between river lots is to be marked as a section corner, but the sides of the post or mound are to be parallel to the side lines of the lots. Whenever a section or quarter-section corner post is so situated that it defines at the same time the boundaries of river lots and those of sections not laid out into river lots, such section or quarter-section corner is to be marked without taking any notice of the river lots, as if the township had been subdivided entirely into sections and quarter-sections.

Form, size and height of the mounds.

51. The mounds erected at the corners of townships, sections or quarter-sections, are to be in the form of rectangular pyramids. The mound thrown up at the corner of a township will be three feet high with sides of base six feet; at sections and quarter-section corners, the sides of the base will be five feet, and the height two and a-half feet.

Earth to be taken from pits.

52. In the formation of mounds, the earth will be taken from four several "pits" three feet square and eighteen inches deep, the

POST IN MOUND.

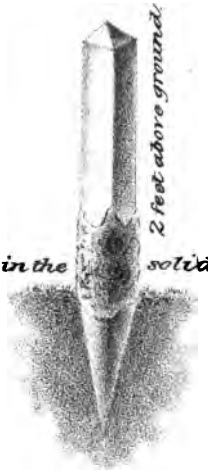
Quarter Section.

3 ins. wide & flattened.

POST.

Section Corner.

3 inches square.

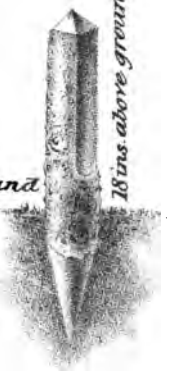


POST.

Quarter Section.

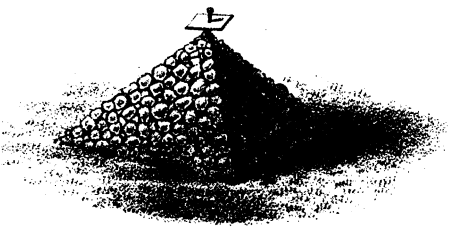
3 inches wide

flattened.



STONE MOUND.

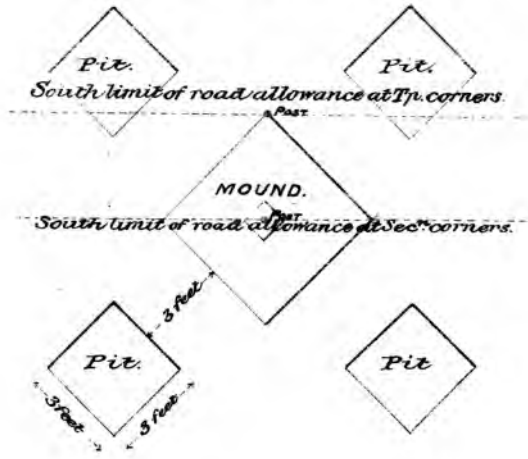
Perspective.



ORDINARY MOUND.

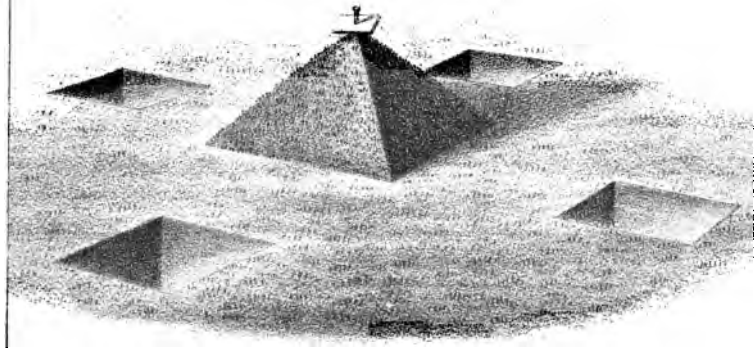
6 feet square for township corners.

5 feet square for all other corners.



EARTH MOUND AND POST.

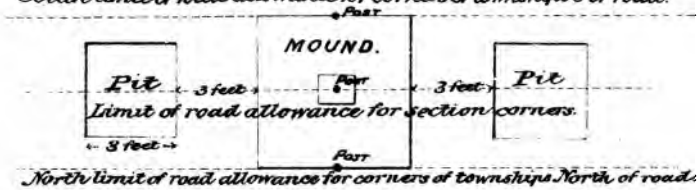
Perspective.



MOUND ON CORRECTION LINE.

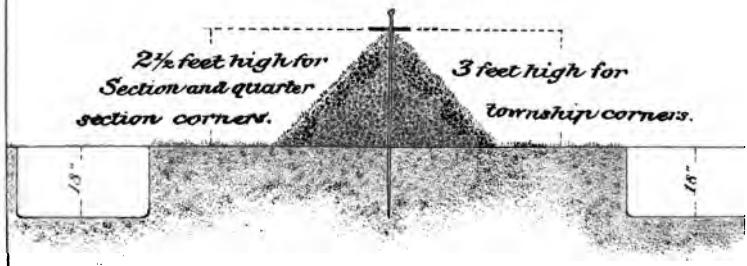
6 feet square for township corners.

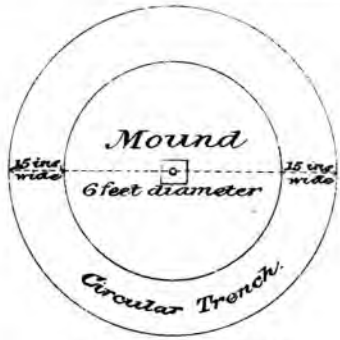
5 feet square for all other corners.



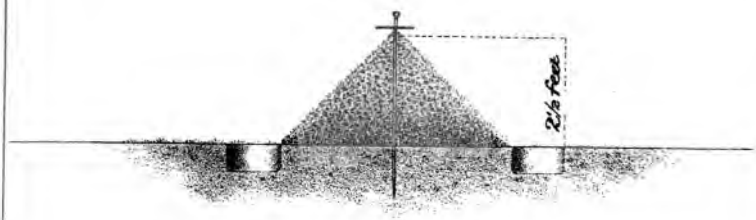
EARTH MOUND AND POST.

Section.





WITNESS MOUND.
Plan.



WITNESS MOUND.
Section.

WITNESS MOUND.
Perspective.

centres of which pits should be, whenever practicable, four feet six inches outside and opposite the centres of the respective bases.

To be formed of solid earth.

53. Mounds are to be formed of solid earth, sod and all foreign substances being excluded, and the earth well pressed down with the spade during the process. The post is to be firmly planted in the solid ground before beginning to build the mound. In order to facilitate the speedy erection of the mound, a rope skeleton may be used. By taking hold of each corner and making a knot of the three lines running to it, the line is carried without becoming tangled; or the spade used may have marked on it the distance from the post to the corners of the mound and to the sides of the pits, and small pickets be planted at those distances and in the proper directions.

Stone mounds

54. In a stony region, the mounds may be built of stone properly piled around the post, so as to conform as nearly as possible in size and shape to the earth mounds.

Angles of mounds to be towards the Cardinal points.

55. On all north and south, and on all east and west survey lines, excepting the correction lines and those across river lots, tin squares, corner posts and mounds shall be so placed that lines connecting the cardinal points will pass through the angles.

Except on correction lines, in which case they will stand square with the line.

56. The tin squares, posts and mounds erected to mark the corners in either limit of the road allowance on the correction or river lots lines will be so placed that lines connecting the cardinal points shall pass through the centres of the bases of the mounds or of the faces of the posts or squares.

Witness mounds.

57. If a township or section corner, in a situation where a bearing tree is not to be found within a reasonable distance, shall fall in a ravine, bed of a stream, or in any other situation where the character of the locality may be unfavorable to the planting of a post or the erection of a mound, the surveyor will perpetuate such corner by erecting a witness mound with iron post at the nearest suitable point. The letters W. M., together with the bearing and distance of the site of the true corner from such mound are to be stamped on the tin square and entered in the Field Book, together with all other particulars connected therewith. Attention is to be paid to the fact that the bearing is to be taken from the mound to the

corner in the case of witness mound, whilst it is to be taken from the corner to the tree in the case of a bearing tree. A witness mound is in form a cone, six feet in diameter and two and a-half feet feet high; the earth is taken from a circular trench fifteen inches wide.

Mounds at township corners.

58. The mounds at township corners, instead of being thrown up around the corners, will be so placed that the posts will stand precisely at the northerly angle thereof.

Mounds at township corners on correction lines.

59. Except on correction lines where the mound will be so placed that the post will stand precisely in the centre of the north or south base, as the corner may be intended for the township south or north of the road allowance.

Wooden posts to be planted twelve inches from iron posts at township corners when there is no mound.

60. Should the site of a township corner fall in a place where no mound can be erected, as in the woods or in a marsh, a wooden post of the ordinary dimensions for section corners, shall be planted twelve inches from the iron post on the side where the mound should stand; such post to be marked I.P. The position of the iron post is besides perpetuated by bearing trees or witness mounds, as directed above.

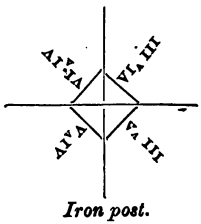
Wooden posts to be bevelled

61. All wooden posts are to be bevelled on top to turn rain.

MARKS ON POSTS.

Township corners

62. On township corners, the upper figure on a given side will indicate the township, and the next one the range, as for instance:



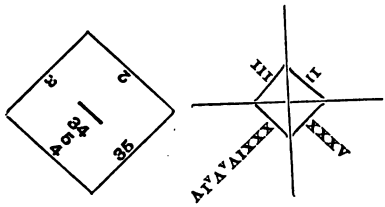
Iron post.

Fig. 3.

For the corner between Townships 5 and 6, and the 3rd and 4th Ranges.

Section corners.

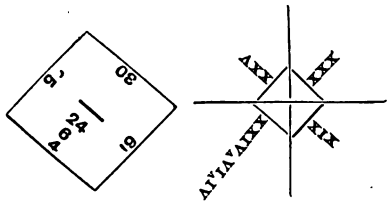
63. On all other section corners, either on town lines or in the interior of a township, the simple number of the sections will be placed upon the corresponding faces of the post or tin square, as the case may be, and in addition, on the south-west side thereof will be marked the number of township and range, as for instance:



Tin square. *Wooden post.*

Fig. 4.

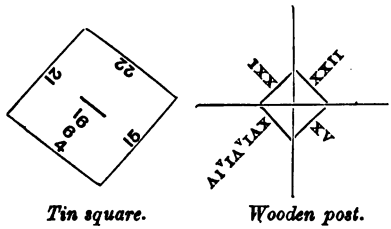
For the northerly corner between sections 34 and 35, Township 5, Range 4.



Tin square. *Wooden post.*

Fig. 5.

For the easterly corner between sections 24 and 25, Township 6, Range 4.



Tin square. *Wooden post.*

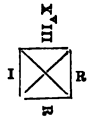
Fig. 6.

For the corner between sections 15, 16, 21, 22, township 6, range 4.

Township corners on correction lines.

64. The corners on correction lines are to be marked exclusively for the townships and sections on the respective sides of the road allowance. Township corners will have the number of section on the west side, the number of township and range on the north side, for posts north of the road allowance and on the

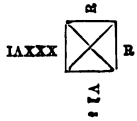
south side for posts south of the road. The letter R for road will be marked on the two other sides, thus:



Iron post.

For the south-east corner of Township 3, Range 10.

Fig. 7.



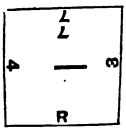
Iron post.

For the north-east corner of Township 6, Range 5.

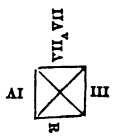
Fig. 8.

Section corners on correction lines.

65. Section corners will have the numbers of sections on the east and west sides, the letter R towards the road and the number of township and range on the other side, thus;—



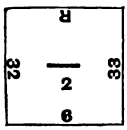
Tin square.



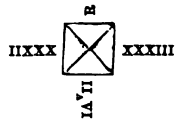
Wooden post.

For the southerly corner between sections 3 and 4, Township 7, Range 7.

Fig. 9.



Tin square.



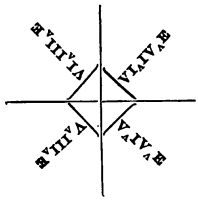
Wooden post.

For the northerly corner between sections 32 and 33, Township 2, Range 6.

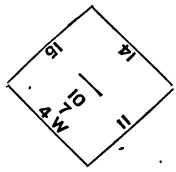
Fig. 10.

Marks of boundaries in ranges numbered from the principal meridian

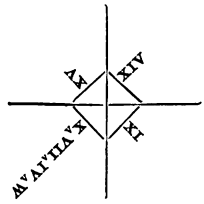
66. In ranges numbered from the principal meridian, the letter W or E will be marked on the post after the number of the range, to denote that it is west or east of the meridian, as for instance:—



For the township corner between Townships 5 and 6, and the 3rd and 4th Ranges east of the Principal Meridian.



Tin square.



Wooden post.

For the corner between sections 10, 11, 14, 15, Township 7, range 4, west of the Principal Meridian.

Fig. 11.

Letters W and E to be marked only for Principal Meridian.

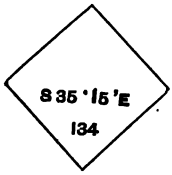
67. The letters W and E are not to be marked for any meridian other than the Principal Meridian. The number of meridian is never to be marked.

Iron posts for section corners to be marked also with a cold chisel.

68. In addition to the marks explained above, the number of the section on the south-west side of a section corner, or the letter R if on the north side of a correction line, shall be marked on top of the post with a cold chisel, in order to serve for the identification of the post, should the tin square disappear.

Post in Witness mound.

69. The bearing in degrees and minutes and the distance in links are stamped on the tin square thus:—



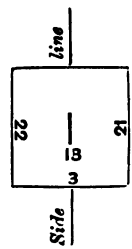
Tin square.

For witness mound, one chain and 34 links to the N. 35° 15' W from the section corner.

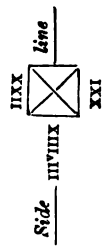
Fig. 12.

Post between river lots.

70. A post between river lots has, on two sides, the numbers of the lots adjoining and on one of the other sides the number of township and range, thus:—



Tin square.



Wooden post.

Fig. 13.

How marks are to be made.

71. Marks on an iron post are to be made with a hammer and cold chisel; on a tin square, with steel letters. On the trees and posts they are to be cut neatly and distinctly with a knife or scribing iron, which is to be kept in good order by a whetstone and small file carried for the purpose.

The Surveyor will be careful to provide himself with these very indispensable implements before leaving for his survey.

THE FIELD BOOK.

Field notes.

72. The field notes sent in to be placed on record in the Dominion Lands Office are to be a fair and exact copy of the original notes taken in the field, and are to be written in the books furnished for that purpose (bound at the side); the books supplied for field use are not accepted as office copies.

Of the field book.

73. The first page will give its title, shewing the nature of the survey, by whom surveyed, and the dates of the commencement and the completion of the work. The second page will contain the names and duties of all assistants, and whenever a new assistant is employed or any one changed, an appropriate entry thereof with the reasons therefor will be made in the field book previous to entering any notes under the changed arrangements. The third page will contain a skeleton diagram, with each section line numbered to correspond with the page of the notes.

74. The field notes must be a faithful, distinct and minute record of everything officially done and observed by the

surveyor and his assistants pursuant to instructions in relation to running, measuring and marking lines, establishing boundary corners, laying off road allowances, &c., and present, as far as possible, a full and complete topographical description of the country surveyed.

Each page to be complete.

75. The field-notes of every section line surveyed must be complete in themselves, and be laid down on a separate page. Section lines are to be entered in the Field Book in the order in which they are run. The chaining must in all cases commence on the inside of the road allowance so as to show for the quarter section and section corners the distances from the corner of the section.

Description of section lines.

76. Section lines are to be described as north and east boundaries of sections, not as south or west boundaries, except on the north side of a correction line where they are properly described as south boundaries of sections 1, 2, 3.....&c. On Indian Reserve boundaries and on lines between different systems of survey, cases may also occur in which the lines surveyed are the south or west boundaries of sections.

77. The measurements on a section line are to be given in all cases exclusive of road allowances.

Abbreviations allowed.

78. The following abbreviations of words, but no others, will be allowed in the notes, that is to say:—

"Sec." for "Section," "Tp." for "Townshhip," "R." for "Range," "N." for "North," "S." for "South," "E" for "East," "W." for "West," "diam." for "diameter," "chs." for "chains," "lks." for "links," "dist." for "distance" or "distant," "W. P. in M." for "Wooden Post in Mound," "B. T." for "Bearing Tree," "W. M." for "Witness Mound," "I. P." for "Iron Post," and "I. P. in M." for "Iron Post in Mound."

Information to be given in notes.

79. The field-notes must be always written down on the spot, leaving nothing to be supplied from memory, and are to give the following information in relation to the survey:—

(*a*) The length of every line run, noting all necessary offsets therefrom, with the reasons for the same.

(*b*) The course and distance for all witness mounds and bearing trees, with the kind and diameter of the latter.

(*c*) The character of corner boundaries, if wooden post, mark "W. P.;" wooden post in mound "W. P. in M.;" if iron post in mound, "I. P. in M.;" stone mound, "Stone M." The above information is to be given on each page for every corner shewn thereon.

(*d*) The distances at which the line first intersects, and, also, where it leaves settler's claims or improvements, lakes, ponds, rivers, bottom lands, swamps, marshes; also, the beginning of ascent, the top and the foot of descent, of all remarkable hills or ridges, with their estimated height in feet above the bottom lands near which they may be situated; also where a stream, lake or pond is crossed, the data used for ascertaining the distance across it.

(*e*) The course, average width and depth, and rate of current of all streams, and whether the water is fresh or salt in the lakes which may fall within the survey.

(*f*) Whether the surface of the country is level, rolling, broken or hilly.

(*g*) The nature of the soil, classifying it, according to its fitness for agriculture, as first, second, third, or fourth rate,—entering the class, at the time of survey, on each quarter-section where indicated in the notes.

(*h*) Depth of loam and kind of sub-soil, where pits are dug.

(*i*) If in timber, the kinds, quality and average dimension thereof.

(*j*) Rapids or falls of water affording mill sites, with estimated fall and supply of water in general terms.

(*k*) Coal deposits, minerals (transmitting specimens of the same), and salt springs, &c., &c.

Field-notes to be distinct and neat.

80. The field-notes must be distinctly and neatly made out in language precise and clear, and their figures, letters, words and meaning, are always to be unmistakable.

Road allowances to be ruled in.

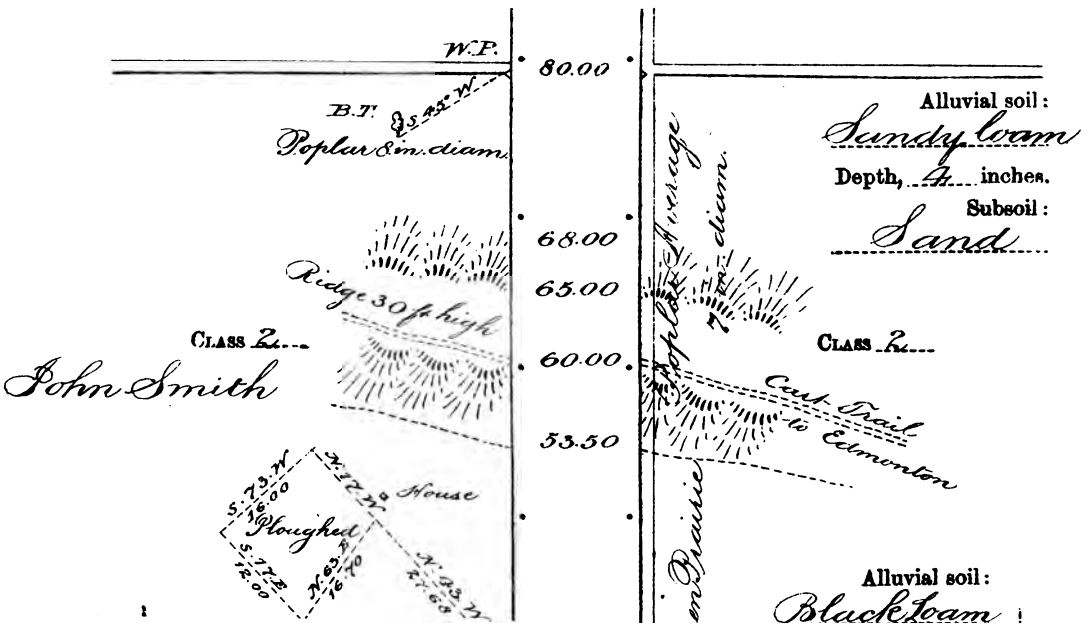
81. The road allowances in the Field Book are to be ruled in the proper position, and the position of corner boundaries indicated.

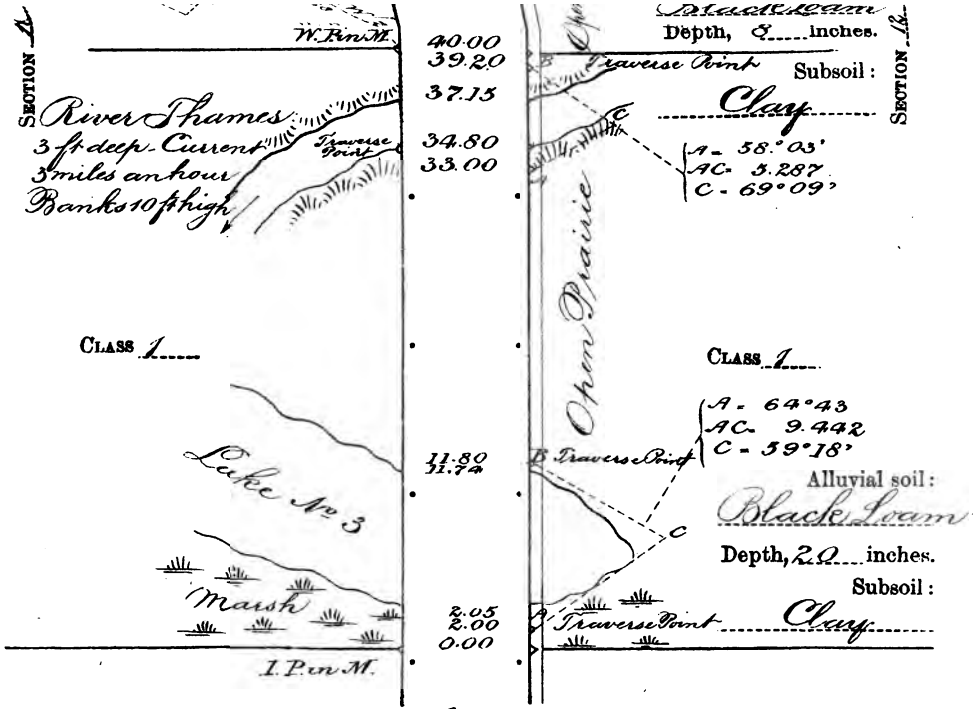
Affidavit to be made.

82. Following the field-notes the surveyor will make affidavit as to the accuracy thereof, according to the form printed in the Field Book, and swear that he has performed the survey himself.

Township 48, Range 10 West of Sixth Meridian.

East Boundary of Section 11 Course: North





The above line was run on the twelth *day of* August 188 3

SUBDIVISION OF TOWNSHIPS INTO SECTIONS.

INSTRUMENT AND METHOD OF SURVEY.

Instrument.

83. The instrument used in subdivision surveys is to be a transit, transit theodolite or solar compass, reading at least to minutes; it shall be inspected and approved by the head office.

As explained in the exposition of the system of survey, all surveys are to be astronomical; they shall therefore be performed independently of the magnetic needle.

The subdivider will receive from the head office, or from the surveyor of outlines, diagrams shewing the outlines surveyed

Chaining to be compared with previous lines.

84. Before the subdivider enters on his survey he will measure carefully one or two miles of the township outline; this will enable him to compare his chaining with that of the lines previously run, and to modify it so as to obtain the best agreement with the township outlines.

Subdivider to establish the north and south boundaries of the township before commencing the subdivision.

85. The meridian exteriors of a township are established by the surveyor of township outlines. The subdivider will therefore commence his operations by running the north and south boundaries of the township, if not previously surveyed.

In order to do so, he will join, by a trial line, the opposite township corners on the meridians, and, returning, plant the posts permanently, making all quarter-sections equal. Table XI will give the number of minutes by which the course of the trial line is to be altered in order to strike the post.

Only one side of a correction line is to be surveyed at one time. The proceedings will be the same as described above.

How townships are to be subdivided

86. A township is to be subdivided by first projecting meridians, and then joining the opposite corners on such meridians by trial lines. Table XI may also be used in this case for correcting the trial lines.

In sub-dividing a township, the quarter-section posts on east and west lines are placed midway between the section corners on the respective meridians, that is to say, both quarter-section sides are made equal.

In closing with a meridian on the north or south boundary of a township, the last quarter-section post on such meridian is at once planted permanently and connected by a straight

line with the section corner on the outline of the township. The directions given above (§ 37) in regard to blazed lines would apply in this case. Should the meridian strike more than 50 links from the post on the outline of the township, such meridian should be entirely resurveyed.

Lines to be surveyed.

87. The only section lines to be surveyed, established and permanently marked as boundaries are those along which the road allowances are. Their total length for every township is forty-two miles and twenty-seven chains, more or less, exclusive of township outlines. The rear line of river lots is also to be surveyed and posted, but posts are not required to be planted on the river front.

Quarter-sections adjoining correction lines.

88. In starting from a correction line, the surveyor will give to the adjoining quarter-section, a depth proportional to those of the quarter-sections at each end of the tier, as shewn on the diagram of the township outlines.

He will be careful to connect with the posts in the inner limit of the road allowance on correction lines, not in the outer limit.

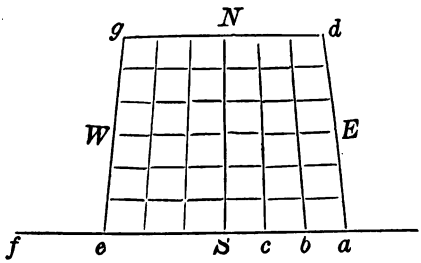


Fig. 14.

It has been explained, in the exposition of the system of survey, that sections are of unequal width, on account of the convergence or divergence of meridians. To better illustrate this fact the convergence has been exaggerated in Fig. 14.

Angles of meridians with east and west lines.

89. The angle formed by the meridians with the east and west lines is different for each meridian and varies uniformly from one corner of the township to the other. The surveyor shall not, therefore, start his meridians at right angles to the township outlines, but he will, in each case, calculate the

angle formed by these two lines, from the data supplied to him with the diagram of township outlines.

Supposing, for instance, the angle *d a f* to be 90°03′, and *g e f* 90°09′, he will use as angles at *b*, *c*, *S*, 90°04′, 90°05′ 90°06′, 90°07′, 90°08′.

The angles between the meridians *a d* or *e g*, and the east and west lines, would be deduced in a similar manner.

Limits of error allowed

90. It follows, from the foregoing, that all quarter-sections on meridians are to be forty chains except in the tiers of quarter-sections adjoining the correction lines, where they should be proportional to the quarter-sections at each end of the tier. Should all the survey lines be perfectly correct, all other sections should have the theoretic width. The maximum error in distance that will be allowed in the closing of any section corner will be fifty links. When the closing error exceeds this quantity, the lines involving the error must be resurveyed. The opposite boundaries of sections are to be within fifty links of equal length.

All distances to be entered in the Field Book such as measured on the ground.

Rivers, lakes and islands to be surveyed.

91. In subdividing townships, all navigable rivers and lakes of twenty acres and upwards, together with any islands that may be in them, are to be accurately surveyed. Lakes occurring entirely within a section, and islands in lakes and rivers, must have their traverse properly connected with the rest of the survey. When the average width of a navigable stream exceeds three chains, the surveyor will traverse both banks of the same, referring to such traverse in his field-notes as on the "right" or "left" bank, as the same would be on his right or left respectively looking down the stream. The outline of the shore shall be determined by a sufficient number of offsets.

Whenever a marsh is so deep that it cannot be forded by men or horses, it is to be surveyed and the area deducted from the sections; but when it is possible to ford it and carry the survey line across, no traverse or deduction should be made.

Traverse points.

92. At those points where township or section lines intersect the banks of a navigable stream or lake, temporary posts or marks are to be established, and the distance across the river between the same ascertained trigonometrically or otherwise, at the time of running such lines. Such temporary marks or posts will be called traverse points, and are to be marked T. P. The survey of a stream or lake will be effected by connecting them with traverse lines and offsets, on the respective sides

of the river or lake, the bearing of such lines being checked at the intersection thereof by each township or section line.

Settlers claims or improvements.

93 Traverse lines shall be run to settlers claims or improvements, and the extent and position thereof shown on the plans of the survey.

Statutory declarations to be obtained from settlers.

94. The surveyor will also obtain from every settler a statutory declaration, on the form supplied, setting forth the date at which he first began continuous occupation of the land; whether he is aware of any conflicting claim thereto; if so, its nature and the name of the claimant.

The settler is also therein to declare whether or not he has previously had a homestead entry, if so, the number of quarter-section and township.

In signing the declaration, the settler is to write clearly all his names in full, and see that there is no accidental error in the spelling of these.

If some of the words in the printed form did not agree with the declaration of the settler, they should be crossed over and new sentences added where necessary.

All declarations from squatters are to be accepted, no matter how many there may be on a quarter section. The only case in which a declaration should be refused is when it is clearly untrue, or in opposition to the facts.

A statutory declaration does not give any right or legal status to the declarant; it is simply for the information of the Department.

No charge to be made for statutory declarations.

95. Surveyors are strictly forbidden to make any charge to the squatters for receiving their declarations, and to say that, by doing so, claims will be secured. Such a practice would expose a surveyor to prosecution for obtaining money under false pretences, and to dismissal from the practice of the profession under clause 102 of the Dominion Lands Act.

It is no part of the duties of a Surveyor to explain the law or give directions to intending or actual settlers for securing land, and it is recommended that parties in the employment of the Department should abstain from giving such advice.

PROGRESS REPORTS.

Sketches of survey to accompany the progress reports.

96. Each progress report shall be accompanied by sketches showing work done up to date. Such sketches shall shew in red the lines surveyed, together with the main topographical features of the country, that is to say, the rivers, lakes, trails, hills, &c.

It is not necessary to use a scale for plotting, a rough estimate of distances is all that is required.

The sketches may be drawn with pencils of different colors.

It should be understood that only the main topographical features are to be shown, and that it is useless to indicate every little swamp, pond or rise that may be found.

RETURNS OF SURVEY.

Account to be placed at the end of the field-book.

97. In addition to what is prescribed for field-notes in general, there will be an account, signed by the surveyor, shewing in miles and decimals of a mile, the distances run on section and traverse lines in the township, with the rates in each case. according to contract, and the total amount for the township,

Final returns.

98. The final returns of survey will consist of:—

(*a.*) Field-notes.

(*b.*) A plan of each township.

(*c.*) A timber plan for each township.

(*d.*) A timber report " "

(*e.*) Formulas of oath of chainmen.

(*f.*) Statutory declarations of settlers.

(*g.*) Accounts in duplicate on the forms supplied.

Report.

99. The surveyor will also subjoin in a concise report such further description or other information connected with the township surveyed as he may be able to afford, which may be useful or necessary to be known, giving a general description of the character of the country, its soil and geological features, timber, minerals, waters, &c.

Plans.

100. The plans shall be on a scale of forty chains to the inch, on the forms supplied by the Department. Every fractional township, however small, is to be shewn on a separate plan.

Township outlines, when surveyed by the subdivider, are to be shown on the same plan as the sub-division.

Length of quarter-section lines.

101. The plans shall exhibit the length of all quarter-section lines as measured on the ground when not exactly forty chains, and the length of every broken part of a section line.

Topography.

102. The plans will show all the topographical features of the country as referred to in the field-

books. The topography is to be represented in manner following, that is to say:—

Bush,—a wash of light green without any imitation of trees.

Brulé,—a wash of light brown without any imitation of trees.

Swamps,—a wash of light yellow, with small strokes of green representing reeds, &c.

Areas. 103. The plans will also show the areas in acres and hundredths of all irregular quarter-sections, *i.e.*, quarter-sections adjoining correction lines, initial meridians, boundaries of reserves, or lines separating different systems of survey, and quarter-sections broken by lakes or streams that have been traversed. All other quarter-sections will be considered as regular, and reckoned as 160 acres in area.

In cases where a quarter-section is divided into two or more parts by a stream or lake large enough to require traversing, each of the parts is to have its separate area shewn thereon.

Contents of township. 104. The area of every river lot is to be marked on the plan and a table shall exhibit the contents of the township, thus:—

Land in sections - - - - -	acres.
Roads - - - - - - - -	"
Water - - - - - - - -	"
Total area - - - - - - -	"

The "Land in Sections" is the sum of the net area of all the quarter-sections in the township, and in a township in which there are no irregular quarter-sections will amount to 23,040 acres.

In the area of "Roads" are included all the road allowances within the township, together with those on the west and south outlines; in a regular township this area will be 433·80 acres.

The area of "Water" is the area of all water that has been traversed within the sections, and should not include any of the road allowances.

Traverse lines. 105. Traverse lines are not to be shown on the plan, but to be plotted on one of the blank pages at the end of the field-book, on which are also shown the shore lines of the lake or stream. In case the lake, pond, &c., is of too great an area to admit of it being plotted on a page, then the plot should be made on tracing linen and pasted in the end of the Field-Book.

Traverse lines are to be plotted on a scale of 20 chains to an inch. Astronomical bearings (not angles), distances and offsets must be given; none of these need be marked on the plot; it is preferable to give them separately in table form, numbering the stations to correspond with numbers on the plot.

Settlers improvements.

106. The extent and position of settlers' improvements are to be shewn in the notes and on the plan; also the names of the settlers who have made statutory declarations, on the quarter-sections which they claim. The names of settlers who have made no declaration are not to be shewn on the plan or in the field-notes.

Timber plan.

107. The timber plan shall be colored so as to shew the predominant timber in the belts or islands met with in the different townships surveyed. The colors to be used to represent timber are as follows: —

Poplar,—light green.

Spruce,—carmine.

Brulé,—brown.

Timber report.

108. In the timber report the surveyor will state whether, in his judgment, from the knowledge gained on the ground, it would be desirable to reserve the timber for the needs of the settlers, or whether it would be advisable to set apart the same as a timber berth; if the latter, he will give a general statement of the quality and extent of timber over 10 inches in diameter suitable for lumbering purposes. If reporting on several timbered townships, he shall make a statement as to their relative value, taking into account the extent, quality and facilities afforded by streams, &c., for getting out the timber.

A timber plan is to be given for every township in which there is wood of any kind whatever.

A timber report shall be furnished for every township. Should there be no wood in the township, the fact is stated. One page of the report is given for each township.

Plans and field-notes returned to surveyor in certain cases.

109. The field notes shall be neatly written, in a clear manner and fair hand. The plans shall be drawn with care and should be fair specimens of draughtsmanship.

Any plans or field notes not complying with the above conditions will either be returned to the surveyor, to be written or drawn again, or prepared by the Department, and the cost charged to the surveyor.

Charges for returns of survey prepared by the Department.

110. Returns of survey are prepared by the Department at the following rates:—

Township plan (old system) - -	$8.00
do (new system) - - -	6.00
Copying a Field Book (old system) per township - - - - -	13.00
Copying a Field Book (new system) per township - - - - - -	10.00

These prices include only a small amount of traverse lines. Extra work on that account will be charged for. Plots of traverses are to be furnished in all cases, as the Department will not undertake to plot a traverse for a surveyor.

EXTRACTS FROM THE DOMINION LANDS ACT.

46 Victoria, Chap. 17.

Surveyors to be prosecuted in case of perjury.

107. The Surveyor-General shall require every Dominion Land or Topographical Surveyor, in addition to the oath by this Act required to be administered to him on receiving his commission as such, to take and subscribe an oath, or make and subscribe an affirmation, on the return of his surveys of Dominion lands, that the same have been faithfully and correctly executed according to law and the instructions of the Surveyor-General; and if it is proved on satisfactory evidence before any court of competent jurisdiction that such surveys or any part thereof have not been so executed, the surveyor taking such false oath or making such false affirmation shall be deemed guilty of perjury, and shall be punishable accordingly; and thereupon Her Majesty's Attorney-General for Canada shall, upon the application of the Surveyor-General, immediately institute a suit upon the bond of such surveyor, and the institution of such suit shall act as a lien on any property owned or held by such surveyor, or his sureties, at the time the suit is instituted.

Chain Bearers.

Chain bearers to be sworn.

108. Every chain-bearer employed in the survey of the Dominion Lands shall, before he commences his chaining or measuring, take an oath or affirmation that he will discharge such duty with exactness according to the best of his judgment and abilities, and render a true account of his chaining or measuring to the surveyor by whom he has been appointed to such duty; and every Dominion Land Surveyor is hereby authorized to administer such oath or affirmation.

Standard of Measure.

Standard of English measurement of length.

109. The measure of length used in the surveys of Dominion Lands, shall be the English measure of length, and every Dominion Land Surveyor shall be in possession of a subsidiary standard thereof,—which subsidiary standard, tested and stamped as correct by the Department of Inland Revenue, shall be furnished him by the said Department, on payment of a

Copies to be procured by D. L. Surveyors.

fee of three dollars therefor; and all Dominion Land Surveyors shall, from time to time, regulate and verify by such standard the length of their chains and other instruments for measuring.

How to renew lost corners and obliterated lines.

Provision in case where the original mound, post or monument cannot be found.

110. In all cases where a Dominion Land Surveyor is employed to run any dividing line or limit between sections or other legal subdivisions, and the mound, post or monument erected, marked or planted in the original survey to define the corner of such section or other legal subdivision, cannot be found, he shall obtain the best evidence that the nature of the case may admit of, respecting such corner mound, post or monument; but if the position of the same cannot be satisfactorily so ascertained, then he shall proceed as follows:—

Township corner.

(1.) If the lost corner mound, post or monument is that of a township corner, he shall report the circumstances of the case to the Surveyor-General, who will instruct him how to proceed;

Corner on the outline of a township.

(2). If the lost corner mound, post or monument is on one of the outlines of a township, he shall join, by a straight line, the nearest undisputed section or quarter-section corners on such outline, and divide such straight line into such number of sections or quarter-sections or other legal subdivisions as the same contained in the original survey, giving to each an equal breadth;

Corner near a correction line.

(3.) Except where in re-establishing the east or west boundary of a township, one of the nearest undisputed corners is on a correction line, in which case all quarter-sections are to be made exactly forty chains, and the deficiency or surplus, as the case may be, left in the quarter-section adjoining the correction line;

Corner near the western corner of a township.

(4.) Except also where in establishing the north or south boundary of a township surveyed under the first system of survey, one of the nearest undisputed corners is the western corner of the township, in which case all quarter-sections are to be made exactly forty chains, and the deficiency or surplus, as the case may be, left in the western quarter-section;

Township corner to be re-established previously.

(5.) When the position of the township corner is also lost, it shall be re-established as aforesaid, previous to re-establishing the outline of the township;

Corner on a meridian road allowance.

(6.) When the lost corner is in the interior of a township on the limit of a meridian road allowance, the surveyor shall connect the two nearest undisputed corners on such limit by a straight line, and divide the distance into such number of sections or other legal subdivisions as the same contained in the original survey, giving to each an equal breadth;

Corner near a correction line.

(7.) Except when one of the nearest undisputed corners is on a correction line, in which case he shall make each quarter-section exactly forty chains and leave the deficiency or surplus, as the case may be, in the quarter-section adjoining the correction line;

Corners in different townships.

(8.) When the nearest undisputed corners on the said limit of a meridian road allowance are in different townships, the outline between such townships shall be re-established previous to re-establishing the meridian;

Quarter section corners on east and west line.

(9.) When the lost corner is that of a quarter section on a line running east and west, the surveyor shall join by a straight line the opposite section corners on the meridians on each side, and give to each quarter-section an equal breadth;

Townships surveyed under the first system of survey.

(10.) Except where in townships surveyed under the firstsystem of survey, the lost corner is in the western row of sections of a township, in which case the first quarter-section is to be made exactly forty chains, and the deficiency or surplus, as the case may be, left in the western quarter-section;

Corners on the meridians to be previously re-established.

(11.) When the position of one of the corners on the meridians is also lost, such meridian shall be re-established previous to re-establishing the east and west line;

Corner renewed to be the true corner.

(12.) In all cases where a surveyor erects, plants or places a mound, post or monument as aforesaid, to renew a lost or obliterated corner, he shall duly take into account any allowance for road or roads, and the corner, or division or limit so established shall be the true corner, or division or limit of such section or other legal sub-division.

How Legal Subdivisions are to be surveyed.

Method of proceeding by Dominion Land Surveyor in laying out a section, half-section, or quarter-section.

111. When in the survey of legal subdivisions a Dominion Land Surveyor has to establish the division line between two sections, he shall effect this by connecting by a straight line the opposite original sectional corners, should these exist, and should they not, by similarly connecting the points established in renewal thereof, in accordance with the preceding clause, giving in either case, the quarter-sections involved an equal breadth. In laying out a half or quarter-section he shall connect the opposite quarter-section posts by straight lines. In laying out other and minor legal subdivisions he shall give to any such subdivision its proportionate share of frontage and interior breadth, and connect the resulting terminal points by a straight line. The lines or limits so drawn on the ground in the manner above prescribed, shall, in the respective cases, be the true lines or limits of such section, half section or other legal subdivision, whether the same shall or shall not correspond with the area expressed in the respective patents for such lands.

To draw Division lines in fractional Sections.

Dividing lines to be drawn from the original corner.

112. The dividing lines or limits between legal subdivisions, in fractional sections, shall be drawn from the original corners (or the points representing such corners, as defined on the ground, in accordance with the provisions of this Act) in the section line intended as the front of the lot;

(2.) Northerly or southerly lines shall be drawn due north or due south;

(3.) Easterly or westerly lines shall be drawn at an angle with the meridian equal to the mean of the angles formed with the same meridian by the lines which are the northern and the southern boundaries respectively of the section.

SECOND PART.

SURVEY

OF THE

STANDARD MERIDIANS

AND

PARALLELS.

GENERAL INSTRUCTIONS.

Dimensions of blocks. A block is to be of the dimensions embracing four townships in longitude and the same in latitude, or sixteen townships in all.

In accordance with the system of division prescribed by law for Dominion lands, its eastern and western exterior boundaries are broken lines, each consisting of two meridians separated by the "jog" on the correction line. The northern and southern limits (base lines) are parts of a polygon described on a parallel of latitude, by laying off, as chords thereto, the successive township sides, forming, as the case may be, the northern or southern outline of the block.

The road allowances along meridians are in all cases to be of the prescribed theoretic width, one chain. That the distribution of excess or defect is among the sections, and is not applied to the roads, will not materially affect the azimuth of those north and south lines involved; the displacement at the extremes—but two-thirds of a link on each mile—being less than ordinary chaining is at all accurate enough to indicate.

Closing of blocks. The surveyor will invariably close his block on the correction line, projecting first the part on one side of the correction line and then the other half of the block. The north and south error in closing is to be divided equally between the two quarter-sections north and south of and adjoining the correction line. In order to correct for it, and to prevent the accumulation of errors, the surveyor may deviate the two base lines of the next block equally and in opposite directions, so as to effect the required correction at the end of the four ranges. Supposing, for instance, the two quarter-sections adjoining the correction line to be each 20 links short, the closing error might be corrected in the next

block by deviating each base 21 seconds, the north base to the north and the south one to the south. It does not necessarily follow that the whole amount of the closing error is to be corrected for; the Surveyor should take into account the probable cause of the discrepancy and correct only for such part of it as he believes will best ensure the closing of the next block. The jog on the correction line is to be left such as found, unless it should show an error of more than one chain and fifty links in the lines of the last block, in which case they would have to be re-surveyed. The limit allowed for the north and south closing error on the correction line is also one chain and fifty links.

The block surveyor will mark, on the correction lines, only the township corners; all other posts are to be planted by the subdivider.

Deflection of base lines.

When it becomes necessary to deflect the base lines for placing them in their proper latitudes, such deflection, unless instructions to the contrary be received from the head office, shall not exceed two minutes, and shall be carried to such a distance as to effect the required correction, except in closing on a Principal Meridian, where the last township corner is to be connected with the post on the meridian by a trial line, the deviation never extending beyond the range or fraction of a range adjoining the meridian.

Measurements.

The method of establishing the lengths and directions of the lines of the survey is to be the following:—

All lines are to be twice measured. This shall be effected by having two sets of chainmen, using Chesterman's continuous steel band chain. The leading one is to be of the length of a standard Gunter's chain; by it are to be kept all topographical and other notes, and posts planted. The following chain, to be used solely as a control, is to be a 100 feet chain.

When, at a section or quarter-section corner, the distances registered by the respective chainings for the length of the quarter section side, differ, in prairie country, more than two links, or, in woods and brush, more than three links, the two sets of chainmen shall return to the last post and measure over again, repeating their measurements until accordance within the limit here prescribed is attained.

Where the surface is so broken or uneven that it would be unreasonable to expect such accordance, and therefore, in a still greater measure, to look for any proper approximation to the absolute length of the interval chained, the surveyor, while continuing to establish the direction and carry on the production of his line in the usual manner, shall have recourse to

such application of trigonometric methods, for obtaining the distances along it, as his judgment and the necessities of the case may lead him to employ. If using triangles, it is to be remembered that the result obtained is more accurate when angles are measured than when they are laid out.

Standard chains. The surveyor shall have a standard chain with which the field chains are to be frequently compared. It will be tested at the Dominion Lands Office, and the temperature of comparison noted. As every ten degrees Fahr. more or less heat would give to measurements a corresponding increment or decrement of somewhat more than half a link to the mile, and that in the North-West Territory a season of field work, extending from early spring to beginning of winter, will include variations of temperature covering a range of at least 80 degrees, and sometimes 100 degrees, the side of a block chained in July or August might, from this cause alone, differ from that of an adjacent one measured in November, fully a chain.

Correction for temperature. In ordinary summer weather, however, the corrections for temperature would, compared with the order of precision of the work generally, be inappreciable, yet they must not be entirely neglected. The temperature error might, in any given case, happen to have the same sign as other uncorrected constants, or accidental errors, whose effect it would then go to aggravate. That in another case, further on, it might tend to counteract these, would not lessen the inaccuracy of position of the boundary monument planted under the first condition.

The surveyor will, therefore apply this correction for all variations of 10° and over, from the normal temperature of 60° for which the chains are compared or adjusted to standard. This he can conveniently do, by allowing half a link to the mile for each ten degrees Fahr., not attempting to note or estimate the temperature of his chain to less than ten degrees. This will keep his corrections in the convenient form of multiples of half links, and render tables unnecessary.

A thermometer attached to the end of a chain near the hand, fails to give the temperature of the rest of the chain; fastened to the middle and allowed to drag on the ground, it is liable to derangement and injury, it is therefore extremely difficult for the surveyor to obtain even a rough approximation of the temperature of his chain. By repeating at convenient times, and under varied conditions, the experiment of placing a pocket thermometer on, or in, the grass or brushwood, as nearly as possible, similarly to the average position of the chain during the trial, and comparing the temperature attained by the

thermometer so placed with that of the air, or indicated by a thermometer attached to the leading end of the chain, a rough idea may be got of the allowances that should, in practice, be made in taking the indications of the latter, or in rudely estimating the temperature of the chain from that of the air at the time.

Attention should be paid to the condition of the chain during measurement, whether wet or dry; a wet chain will have its temperature lowered to a great extent, principally in dry weather. The colour of the chain also has some influence; a black or dark blue chain will absorb more heat than a bright one.

Steel band chains are very liable to break; this fact cannot be impressed too strongly upon the chainmen. In case such an accident should happen, the surveyor ought to be provided with a small steel punch with sharp edges, a few copper rivets and some brass plates cut to the width of the chain. Holes can be punched through the steel band and the repair effected with two fish plates riveted together with the chain.

Correction for inclination.

Besides the small plummet line that should be carried by the chainmen to enable them to get correctly past minor irregularities of surface, the assistant should carry an Abney or Locke pocket level clinometer, by which he can obtain the inclination, and thus permit the chainmen to use the more accurate method of chaining on the inclined surface, instead of the one requiring them to hold their chain level and entailing a continuous repetition of plumbing down from the high end to the pin in the ground.

Use of clinometer.

In using his clinometer, the assistant will stand at one end of the slope, one of the chainmen standing at the other end, and he will sight through the instrument to some part of the chainman's body, the height of which shall have been previously ascertained to be the same as the height of his own eye. Such point will easily be found by using the clinometer at zero, the assistant and chainman standing close together and on the same level.

Chainage—how entered in the Field Book.

The field-books supplied to surveyors contain a table of the correction per chain for given angles of slope, and also a form for applying the corrections to the chainage. The first number to be entered in this form is the length, in links of the chain used, of the quarter-section to be laid out. When the chain can be adjusted for length it is adjusted so as to be standard at 60° Fahr.; the number to be entered is then the theoretic length of the quarter-section, forty chains or forty-one chains as the case may be. When it cannot be adjusted

the surveyor ascertains its length at 60° Fahr. by comparison with a standard, and computes the number of links of *his chain* required to give, at the above temperature, the proper length to the quarter-section. With a chain too long, the number of links will be less than the true length and *vice versa*. This number being entered in the Field Book form, the corrections for slope will be written underneath; they are in all cases to be added. The correction for temperature, one-quarter of a link to the quarter-section for every ten degrees Fahr., is to be entered next; it is added when the thermometer is below 60° and subtracted when above the same.

At the end of the quarter section, the algebraic sum of the quantities entered will show the number of chains and links to be actually measured on the ground in order to give to the said line its exact length, forty or forty-one chains. The same process will be followed to find the distance to be measured for the section corner.

It will be seen that the distance for the topography, being entered as found in the field, will be in error by the amount of the correction to the chainage. This quantity being generally small, may be neglected for the topography but the posts should be entered at their true distances.

The method of chaining along the slopes and correcting for inclination, will be applied only with the Gunter's chain, by which posts are planted and boundaries ascertained; the 100 feet chain, being solely as a control, will be used in the ordinary manner, breaking chain when its full length cannot be levelled.

All calculated distances to be checked.

When the distance across an obstacle is determined by a triangle, the surveyor must be careful to check it by another independent operation, either another triangle or a micrometer measurement, so as to conform to the principle of double independent chainage.

If a second triangle be adopted, having the side to be calculated common with the first triangle, it will be sufficient to set up the instrument at both ends of this side; any error in the angles would be shown by the calculation. In all triangles, the angle opposite to the base shall be called B, the angle opposite to the side to be calculated C and the third one A. The calculation is to be made according to the form given on p. 40 which refers to the specimen of field notes (opposite p. 20.) The distance to the near side of the obstruction being entered at the proper place, it is only necessary to fill the form to have the distance to the far side. From this last point the chainmen start with the number of tallies and pins and the fraction of chain found by the calculation.

½ Sect.	40.140	Triangle No. 43				b=	9.442
Slope.	3	*Observed Angles.*		*Corrected Angles.*			
"	13	A=	64° 43′	64°	44′	log. b=	0.97506
"	7	B=	55 56	55	57	cosec. B=	0.08168
"	24	C=	59 18	59	19	sin. C=	9.93450
"			179 57	180	00	log. c=	0.99124
"						c=	9.800
"		Distance to near side of obstruction=					⌈0.050
"		Distance to far side " =					9.850
"							
"		Triangle No. 44				b=	5.287
"		A=	58° 03′	58°	02′	log. b=	0.72321
"		B=	52 51	52	50	cosec. B=	0.09861
"		C=	69 09	69	08	sin. C=	9.97054
Th. cor.	— 5		180 03	180	00	log. c=	0.79263
½ Sect.	40.182					c=	6.200
Sect.	41.140	Distance to near side of obstruction=					37.000
Slope.	11	Distance to far side " =					43.200
"	6						
"	18	Triangle No.....				b=	
"	23	A=				log. b=	
"	2	B=				cosec. B=	
"	1	C=				sin. C=	
"	1					log. c=	
"							
"						c=	
"		Distance to near side of obstruction=					
"		Distance to far side " =					
"							
"							
Th. cor.	— 7						
Sect.	81.377						

Surveyor to pass round large lakes or deep marshes.

Should the extension of a block line be hindered by a very large lake or marsh, the surveyor may pass round the same projecting for the purpose the adjacent township lines. In working round in this way to arrive at and take up the continuation of the block line on the opposite side of the obstruction, the surveyor will regularly post off and mark out all township, section and quarter-section corners on the several lines, reporting the circumstance fully and sending all the field notes of such additional work forward with the returns of survey.

Instruments.

Description of transit theodolite.

The surveyor in charge shall have a reiteration transit theodolite, with a six-inch horizontal circle reading by three verniers to 0°.001, and a three-inch vertical circle with two verniers to 0°.02, as a finder for stars in day time.

The telescope has an objective of one and a half-inch diameter, and nine inch focus, supplied with direct eye pieces of power equal to 12, 18 and 32 for terrestrial work, and a diagonal eye piece with powers of 30 and 60 for star work. In using his instrument, the surveyor should always employ the highest power compatible with satisfactory definition. The instrument is provided with three verniers, because, by reversing the telescope and turning the azimuth plate 180°, readings will be obtained on the same object, at six equidistant points of the circle, thus tending to eliminate periodical errors of graduation to the same extent as an instrument having six verniers.

Decimal graduation.

The degree is subdivided decimally, instead of, as usual, into minutes and seconds, in order to facilitate the taking of a mean of a number of readings of the three verniers, and to lessen the chances of blunder, in so doing, by substituting the more familiar process of division of quantities counted by tens to the less familiar one of dividing quantities counted by sixties.

A small magnetic needle, attached to the instrument, is useful in finding stars in day time, when the surveyor may happen to be elsewhere than on a line of known azimuth.

Assistant's instrument.

The assistant will be provided with a reiteration transit having a four-inch horizontal circle reading to minutes or to 0°.01; it will be used for measuring the angles of small triangles, laying out offsets for passing obstacles on the line, measuring the bear-

ings of witness mounds or bearing trees, giving to the axemen the direction of the line to be opened out in the bush, and generally to do whatever will be done with sufficient accuracy and more conveniently than with the larger instrument used in the production of the line.

For his astronomical work the surveyor must be provided with a sidereal pocket chronometer or watch conforming in quality and performance to what is here set forth as desirable for the purpose.

Pocket chronometer or watch for astronomical work.

For use in this service a watch with good lever escapement is to be preferred to one with chronometer escapement; the latter is not so well fitted to withstand the unavoidable vicissitudes of rough carriage while the wearer is jolting over lumpy prairie in a waggon, riding on horseback, or climbing over the trunks of prostrate trees in a windfall. In jumping down from one of these, or from his saddle, the escapement is very liable to catch, and in doing so injure the point of one of the fine scape wheel teeth, rendering the watch useless till repaired by skilful hands.

The best suited to the purpose is a well-made lever watch, having a compensation balance that has been subjected to trial in temperatures of opposite extremes, say freezing and 80 Fah., and carefully adjusted to good performance in both, and with good hard Breguet hair spring, well coiled and properly pinned, that is to say, being, by trial, in conjunction with its balance, fastened at such points in its length, and given such initial and terminal curves, as to secure isochronal vibrations of the balance.

This may be tested by varying the conditions of resistance to the driving power, which may be conveniently done by varying the position of the watch so as to produce change in the length of arcs of vibration.

A good watch should include in a range of 5 seconds all the differences of daily rate that would occur in running it for twenty-four hours in each of the six positions—flat on back, on face, on edge XII up, VI up, III up, IX up.

Directions.

Azimuth of lines.

The directions of the east and west exteriors of a block being throughout coincident with those of meridians, their azimuth is constant; but, on its northern and southern outlines, consisting of the four successive chords to a parallel of latitude that are formed by the bases of the townships standing on that parallel, the

azimuth varies with the progression along a chord from one corner of a township to the other, because the direction of the line is the same throughout, whilst that of each successive meridian to which it is referred, differs from the direction of any preceeding one by the amount of their convergence.

Reckoning azimuth from zero at the north point round through east, south and west,—90°, 180° and 270°,—and representing the convergence of the two meridians forming the east and west outlines of a township by C, the azimuths of the chord forming its base would, at each successive section corner, beginning at the eastern corner of the township, and going westward, be $270 + \frac{C}{2}$, $270 + \frac{C}{3}$, $270 + \frac{C}{6}$, 270, $270 - \frac{C}{6}$, $270 - \frac{C}{3}$, $270 - \frac{C}{2}$, the deflection angle between a chord produced and the next one equalling C.

The quantity given in the accompanying geodetic tables Nos. III and IV, under the heading of "chord azimuth," is equal to $90° - \frac{C}{2}$, which substracted from 360° gives the above quantity $270° + \frac{C}{2}$. C is given in those tables under the heading "Deflection."

Azimuth observations to be made on Polaris.

The reference of lines to an astronomic meridian, in order to obtain their direction, or to check the accuracy of their production, shall, as a rule, be made by observations on Polaris.

The telescopes used being amply powerful to show stars of the second magnitude within a few hours from noon, and stars of the third magnitude in twilight when it is still clear enough to read the graduation, the observations shall be taken in day time, whenever practicable.

Besides avoiding the errors peculiar to all artificial illumination, and likely to be specially developed in the case of field work in unsheltered positions, and with light from reading lamps held by hand, inconstant in direction and unsteady, daylight observations have the advantage that they are conveniently made with the instrument at one of the stations for the ordinary production of the line, and during its progress, without materially, if at all, interfering therewith. Day observations also give the surveyor more time in evening in camp for their reduction, and for checking his own and his assistants' work generally.

Programme for observing.

In observing for azimuth, the surveyor will adopt the following programme:

The instrument being in the position which places the vertical circle to the observer's right hand when looking through the telescope, it will be directed to the reference object and the verniers read, then to the Pole Star, noting the time of pointing and the reading of the verniers. The level of the

azimuth plate is read or the inclination of the horizontal axis measured with the striding level.

Reversing the instrument by revolving the telescope and turning the upper plate 180° in azimuth, so that the vertical circle is now to the left of the observer, the telescope is directed to the Pole star, the level recorded and readings taken on the reference object, as before reversal.

In strong daylight, the surveyor will experience some difficulty in finding Polaris, unless his telescope be in the precise direction of the star. He will readily place it so by help of the quantities given in Table VI. Its use does not require any explanation.

Causes of error—yielding of stand.

In making these observations, as in angular measurements generally, care should be taken when turning the instrument in azimuth by hand, to use the same forward or backward motion throughout for every pair of pointings in same position, the angle between which is intended to be read on the horizontal circle. This tends to obviate the effect of any yielding in the instrument stand to that part of the impulse of revolution that passes down through the foot-screws to the stand head. In some much-used forms of stand this occurs to a notable extent, and as there is no certainty that in springing back, or "untwisting," the stand resumes exactly its original position, serious errors are to be apprehended in their use, unless the utmost care is taken. A source of similar error is looseness of foot screws in their nuts. The pinch screws closing these last should always be screwed up so tightly as to have the levelling screw turning stiffly in the nut. Even though this may entail more rapid wear of the screws, and be less convenient to the observer in bringing quickly, and with nicety, his level bubbles to their desired position, the certainty that it ensures warrants it.

Direction of motion of tangent screw.

The tangent screw should always be turned so as to push against its counterpoise spring; because in turning in the opposite direction, the spring might fail to bring back the azimuth plate at once and do so only during the interval between the observation and the reading of the verniers. Should there be any drag of the verniers, this will also prevent it affecting the measure, as the motion will always be in the same direction.

Observations with a two vernier instrument.

If any accident has occurred to a three-vernier instrument, and a two-vernier instrument has to be used, then, after the two observations as above, a third should be made, shifting for the purpose the lower limb 90° in azimuth, if the instrument be a repeti-

tion one; 120° by lifting it off stand, and changing foot-screws one interval round, if it be a reiteration instrument, *i. e.*, one which has no motion of lower limb.

Reference object. The reference object for azimuth work, whether in the day time a picket on the line, or at night a bulls-eye lantern, should be, if possible, at least half a mile from the observer.

Such a lantern having to slide on over the lens a tin cap, across which there is a vertical slit having an opening in width of about quarter of an inch, makes an excellent reference object.

In the case of night observations, the angle between line and reference object is to be determined before observing, and not to be left till morning, thus subjecting the reference object to the risk of accident or removal.

Surveyors to observe for azimuth every clear day. Surveyors are expected to observe for azimuth every clear day. With proper care in transporting the instrument, the levels will seldom get much out of adjustment, and then the complete observation for azimuth as above does not require more than ten minutes; generally it can be done without interfering with the work on the line. The reduction will take about fifteen minutes. It is hoped that with the forms and tables supplied to surveyors, the work has been made so short and easy that no objection to the frequency of observation should fairly exist.

Watch error. The watch error is required for the reduction of the observations; it may be found very simply, when on the line, by placing the telescope in the meridian and observing the transit of a star. The time thus deduced is sufficiently accurate for the purpose.

When not on the line, the transit of a star through the vertical of Polaris may be observed, and the time found by following the directions given in the explanation of Table VII. The observations for time are entered in the form at the end of the book of record of astronomical observations.

Value of one division of the level. The value of one division of the level is required for the reduction of azimuth observations. To obtain this, the level is placed on the azimuth plate parallel to the plane of revolution of the telescope, and a rod, with two marks upon it, is placed vertically at a certain carefully measured distance from the instrument and in the direction of one of the foot screws. The bubble is brought, by turning the foot screws, close to one end of the tube, and the telescope directed to one of the marks on

the rod and firmly clamped. The front foot screw is then moved until the telescope be directed to the other mark and the displacement of the bubble noted. The difference between the inclinations of the level in the two positions will be deduced from the distance of the rod and the interval between its marks; dividing it by the number of divisions of displacement will give the value of one division.

Formula for azimuth. Surveyors are at liberty to use any formula or process for reducing their observations, but, as forms and tables could not be prepared for every method, the following formula has been adopted; for convenience, with regard to future reference, it is desirable that all surveyors should adopt it:

$$\text{Tan } Az = \frac{\text{Tan } P \text{ sec } \phi \text{ sin } t.}{1 - \text{tan } P \text{ tan } \phi \text{ cos } t.}$$

where P. ϕ t. are polar distance, latitude and hour angle respectively.

Reduction of azimuth observations. In the form of record of astronomical observations (see page 48), the letters R and L represent the positions of the instrument, circle right and circle left, H. C. R. is for horizontal circle reading; R. O. reference object; R. A. right ascension, and Az. azimuth.

Representing by W. and E. the readings of the west and east end of the level, the level correction will be equal to the inclination

$$[\tfrac{1}{2} (\text{W} - \text{E}) \times \text{value of one division}]$$

multiplied by the inclination factor.

It is to be added to or subtracted from the mean H. C. R. according to signs, that is to say, added when the west side is high or when W. is greater than E., and subtracted when smaller.

The logarithm of tan P is given for every tenth day in the annual tables supplied to surveyors; an interpolation at sight will give it for any intermediate day.

The logarithms of secant and tangent ϕ are given in Table V for the north side of every section.

The subtraction logarithm is found in Table XII, using as argument A the logarithm of "tan P tan ϕ cos t." The corresponding logarithm, B, is to be added to the logarithm of "tan. P sec ϕ sin t" when t is comprised between 0^h and 6^h, or 18^h and 24^h; it is to be subtracted when t is comprised between 6^h and 18^h.

The following examples, one in each quadrant of a revolution of the Pole star, will show how the calculation is to be made:

Ex. Required for the 6th July, 1880, at a point on the 6th base line, or 20 townships north of the 49th parallel, the azimuth of Polaris for hour angles of $2^h\ 10^m$, $9^h\ 32^m$, $16^h\ 44^m$, and $19^h\ 52^m$.

	For t = 2h. 10m.		For t = 9h. 32m.	
Tan P (annual table)	8.36640	8.36640	8.36640	8.36640
Sec ϕ (Table V)	0.19877	Tan ϕ, 0.08772	0.19877	0.08772
Sin t	9 73022	Cos t, 9.92603	9.77946	9.90235
	8.29539	8.38015	8.34463	8.35657
Subt. log (Table XII)	+0.01030		−0.00976	
Tan Az	8.30569	Az = — 1.1581	8.33487	Az=—1.2386

	For t = 16h. 44m.		For t = 19h. 52m.	
Tan P (annual table)	8.36640	8.36640	8.36640	8 36640
Sec ϕ (Table V)	0.19877	Tan ϕ, 0.08772	0.19877	0·08772
Sin t	9.97567	Cos t, 9.51264	9.94593	9.67161
	8.54084	7.96676	8.51110	8.12573
Subt. log (Table XII)	−0.00400		+0.00576	
Tan Az	8 53684	Az = 1.9715	8.51686	Az=+1.8829

The log. tan. Az. is transformed into logarithm of the arc by adding log. T (see page 49), thus avoiding the calculation of proportional parts.

The azimuth by account, when the R. O. is one of pickets on the line, is the theoretic azimuth of the line at the place of observation.

The direction of the line is corrected by placing the instrument a certain number of inches from its former position at right angles to the line. This offset is found by multiplying the distance of the back picket by the tangent of the correction.

SPECIMEN OF RECORD OF

Place, 45 chs. E. of N.E. corner Sec. 31, Tp. 28, R. 17, W. of 2nd M.

Face.	Object observed.	Chronometer Time.	Horizontal circle reading. A.	B.	C.
R.	R. O.		173·082	080	084
	Polaris.	h. m. s. 13 53 25	83·445	443	447
L.	Polaris.	13 56 33	·473	475	477
	R. O.		173·079	082	084

Chr. Time.	13 53 25	13 56 33	Tan. P.
Chr. Error.	— 2 13	— 2 13	Sec. and tan. ϕ
Sid. Time.	13 51 12	13 54 20	Sin. and cos. t
Polaris R. A.	1 15 43	1 15 43	Sum.
t	12 35 29	12 38 37	Subt. log.
			Tan. Az.
Log. 792.	2 . 8 9 8 7 3	Distance of back picket=53·65chs.	Log. T.
Log. tan. corr.	5 . 6 8 9 0 4		Log. Az,
Log. distance.	1 . 8 0 3 8 0		Az.
Log. offset.	0 . 3 9 1 5 7		H. C. R. on star.
Offset in inch.	2 . 4 6		True North.
			H. C. R. on R. O.
			Azimuth R. O.
			Mean.
			Az. by account.
			Correction.

TABLE OF INCLINATION FACTORS.

No. of Township.	Hour angle of Polaris. 0h or 24h	3h or 21h	6h or 18h	9h or 15h	12h
0	1.20	1.18	1.15	1.12	1.10
20	1.28	1.25	1.23	1.20	1.17
40	1.37	1.34	1.30	1.28	1.25
60	1.46	1.42	1.39	1.36	1.33
80	1.56	1.52	1.49	1.45	1.42

AZIMUTH OBSERVATIONS.

Date, 21st July, 1881. One division of level = 0·0011

Level W +	Level E —	Level Correct.	Mean H. C. R.	Corrected mean H.C.R.
				173.0820
10.2	8.5	+ 0.0019	83.4450	83 4469
11.3	7.4		.4750	.4769
				173.0817
8.36465		8.36465	8.36465	8.36465
0.20533		0.09855	0.20533	0.09855
9.18811		9 99477	9.22454	9.99381
7.75809		8.45797	7.79452	8.45701
— 1229			— 1226	
7.74580			7.78226	
1.75812			1.75812	
9.50392			9.54038	
0.3191			0.3470	
83.4469			83.4769	
83.1278			83.1299	
173.0820			173.0817	
89.9542			89.9518	
			89.9530	
			89 9502	
			.0028	

TABLE OF LOG T.

Tan. Az.	log. T.
	1.75812
7.875	11
8.045	10
.137	09
.207	08
.259	07
.299	06
.335	05
.366	04
.391	03
.415	02
.435	01
.454	00
.472	.75799
.490	98
.505	97
.519	96
.532	95
.544	94
.556	93
.567	92
.579	91
.588	90
.598	89
.608	88
.617	87

Record of azimuth observations to be part of the returns.

The observations will be entered in the note book of astronomical observations at the time they are made, the calculations made either in pencil or in ink, and the book will be sent in as part of the returns of survey. No copy will be accepted.

(See specimen page 48.)

Production of Line.

Only one flagman to be employed.

In producing the line the surveyor will employ but one flagman, a forward picketman; a back flagman is not necessary, as the surveyor can have left by his men at each of his instrument stations a picket which he can set himself before leaving it.

Pickets.

Perfectly straight pickets are not indispensable; a part of the picket, exactly in the line, may be indicated by some visible mark and only this part used in the production of the line.

The flagman carries an ordinary surveying picket, about nine feet long, and terminated at the lower end by an iron point exactly in the axis of the picket. A small bubble, placed at right angles to the axis would be a valuable adjunct to ensure verticality.

Production of the line.

When the flagman comes to the place where a new station is to be established, the surveyor will give him roughly the direction of the line. A wooden slab, held to the ground by two small wooden pins or by stones on the ends, will then be placed at right angles to the line at the point determined as above and in all subsequent operations, the picket will be held on the slab, and its position marked with a pencil.

In setting a point forward on his line, the surveyor will be careful never to do it in one position only of his instrument; in all cases, first making his back and forward sights circle right, then reversing his instrument, repeating them circle left, and having his flagman so instructed that the latter shall consider he has to make in each a separate and independent setting of his picket between which, if there be any difference, the surveyor is carefully to mark the middle-point. Then the process is to be once repeated, so that there shall be two pointings in each position of the instrument on the back and forward pickets respectively, or eight pointings in all.

The same rule as to the reversion and number of pointings is to be observed in offsetting the line to get past long reaches unfavorable to chaining or triangulation.

It will be seen that the slab ought to be of such a length as to allow play for collimation.

Deflection angles turned off by deflection offsets.

The deflection angles at township corners on the base lines can be turned off without any reading of the graduation, by using the "deflection offset" given in Table III. This deflection offset is the length, at the distance of one chain, of the tangent of the deflection angle, or the angle between the chord forming a township side and the next chord. When the surveyor comes to a township corner, the last picket before the corner is placed south of the line, at a distance equal to the deflection offset of Table III, multiplied by the distance from the corner, and the instrument, instead of being set up over the forward point previously ascertained, is placed north of the line, at a distance equal to the deflection offset multiplied by the number of chains between the instrument and the corner. The line is then produced from the back picket in the ordinary manner.

Supposing, for instance, that it should be required to turn off the angles at a township corner on the seventh base line, the back picket being 12 chains behind the corner and the instrument 15 chains beyond the same corner, the back picket will be planted at $12 \times 1{\cdot}501$ or 18·01 inches south of the line, and the instrument set up at 15×1.501, or 22·51 inches to the north.

How to turn at the corners of a block.

At the corners of the block, the surveyor will turn the required angle approximately, and the flagman will hold his picket at the point so determined, while the surveyor measures accurately the angle thus turned off, in the manner explained below for measuring the angles of triangles. If the angle is not what it should be, the direction of the line will be corrected by offsetting the instrument at the next station.

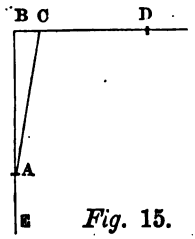


Fig. 15.

Should the corner fall in such a place that the angle could not be measured correctly, as for instance at *B* (Fig. 15), one of the stations, *C*, being too near the corner, the surveyor will have the angle at *B* approximately turned off by his assistant

with the small transit, and measure the angle *E A C*. He will then set up his instrument at *C*, determine approximately the next station *D*, and measure *A C D*. The sum of the two angles *E A C*, and *A C D*, should be equal to 180° plus the angle to be turned off at *B*. The error, if any, is corrected by offsetting the instrument at *D*.

Scheme for triangulation.

In cases where a triangulation would be necessary, the following would be the scheme of direction readings at a station in a chain of triangles. Taking the stations as bearing on one side of the chain the odd numbers 1, 3, 5, 7, &c., and on the other the even ones 2, 4, 6, 8, &c., and assuming for instance the observer to be at Station 6, and representing by the letter *r* the respective azimuthal circle readings, corresponding to the successive pointings on the station under whose number the letter is placed, the series of readings would be:—

	St. 4.	St. 3.	St. 5.	St. 7.	St. 9.	St. 8.	St. 4.
Circle R	r	r	r	r	r	r	r
" "	r	r	r	r	r	r	r
" L	r	o	r	r	o	r	r
" "	r	o	r	r	o	r	r
	r_4	r_3	r_5	r_7	r_9	r_8	r'_4,

Representing the sum of the readings on such station by the letter *r*, with the subscript number of that station. The mean direction reading for each, would, representing it by letter *d* with similar subscript number, be—

$$d_1 = \frac{r_4 + r'_4}{8}, \quad d_3 = \frac{r_3}{2}, \quad d_5 = \frac{r_5}{4}, \quad \text{&c., &c.}$$

And for one of the triangles 3...4...6 the angle at station 6, between the directions 6 to 3, and 6 to 4, is:

$$3{\cdot}6{\cdot}4 = d_4 - d_3.$$

The direction of the diagonals 6.3 and 6.9 are taken out but once in each position, because they are not intended for calculation of sides, but only to serve where a gross error may have occurred, such as sighting on an object not a station, in detecting by combining therewith the various directions involved, at what station the error has been committed.

Great care should be exercised in setting station poles, to place them truly over their central marks, and in making them securely and exactly vertical; also, in centring instru-

ment over these station marks when observing. Any neglect in this respect completely neutralizes the approximation to accuracy that is aimed at by the reiteration of the angles laid down in the programme.

Reports and Returns.

Monthly Returns. Block surveyors shall send reports of progress at intervals as nearly monthly as circumstances will allow; such reports to be accompanied by sketches, on the scale of six miles to the inch, on the printed forms supplied, shewing in red the lines run up to date, the deviations of the base lines, the depth of quarter-sections adjoining the correction lines and the length of the jogs on correction lines. The general character of the surrounding country shall be indicated by the following tints:—

Bush,—green.
Prairie and bluffs,—small patches of green.
Prairie,—blank.

They will also inform the township outlines surveyors, working within their blocks, of the depth of quarter-sections adjoining the correction lines, the length of the jogs on the correction lines and the deviations of the block lines.

Final Returns. The final returns of the survey will consist of—

1. A diary for the time the surveyor has been employed.
2. Plans of the survey, on the scale of forty chains to the inch on the forms supplied. They will show all the topographical features of the country crossed by the block lines, in the manner prescribed for subdivision surveys. (See § 102. First part.)
3. A copy of the field notes.
4. The record of astronomical observations.
5. The formulas of oath for chainmen, duly sworn to.
6. A general report of the survey.

SURVEY OF THE TOWNSHIP OUTLINES.

Instruments.

The instrument to be used for the survey of the township outlines shall be a transit theodolite with a vertical circle, both circles reading at least to minutes. It shall be inspected and approved by the head office.

Method of subdividing Blocks.

In surveying the meridian exteriors, the surveyor will commence at one of the township corners of the base line.

He will carefully measure one or two miles of the base before beginning the subdivision of the block; this will enable him to compare his chaining with that of the lines previously run.

The meridian is to be carried only as far as the correction line, where a temporary post is left. The corresponding meridian is then surveyed from the township corner on the next base to the same correction line, and the jog run between the ends of the two meridians, on the proper azimuth. The north and south closing error is distributed equally between the two quarter sections, adjoining and on each side of the correction line, so as to make both quarter-sections of the same depth. The marks for township corners are now permanently established.

No posts are to be planted by the surveyor of township outlines, between the township corners on the correction line.

Measurements. Any difference in the chainage of two meridians will cause corresponding deviations in the east and west lines joining the same; great care should therefore be bestowed on the measurements. Chesterman's steel band chain shall be used and every precaution taken to ensure accuracy.

Limit of error. The mean average deviation of any twelve miles meridian should not exceed one minute and thirty seconds, but single errors may be larger, if frequent observations are taken. Being distributed according to the law of accidental errors, they will, in a certain measure, compensate each other.

Observations for azimuth. The direction of the line with reference to the astronomical meridian will be readily obtained by observing the sun's altitude before or after noon. If the

telescope is reversed during the observations, so as to eliminate instrumental errors, this method will give all the accuracy required, and will exempt the surveyor from having to take observations at night.

The instrument should be provided with a coloured glass to enable the surveyor to look at the sun through his telescope.

Azimuth by the sun.

The observations will be made first with the vertical circle to the right of the observer and then with the circle to the left, reversing the telescope and turning the azimuth plate 180° in azimuth.

In the first instance the image of the sun is to be brought in one of the angles formed by the wires in the telescope so as to be tangent to both wires at the same time, and the same process is to be repeated with the instrument in the second position, but with the sun's image in the opposite angle. In order to bring both wires tangent to the sun's limb at the same time, the sun's image should be placed so as to move towards one wire while going off the other; the former wire is kept tangent to the sun's limb by the proper slow motion screw until both wires are tangent at the same time. In the opposite angle of the wires, the same process

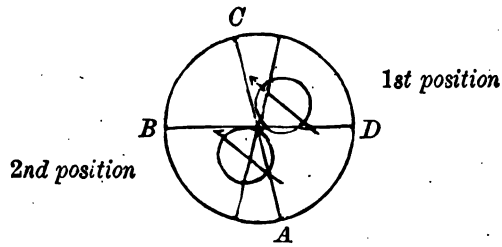


Fig. 16.

is repeated with the other slow motion screw. Fig. 16 illustrates how the sun's image should appear in the afternoon with an inverting telescope, the apparent direction of the sun's motion being shown by the arrows. In the first position the wire *A C* should be kept tangent to the limb with the slow motion in azimuth, until *D B* is also tangent. In the second position *D B* would be kept tangent to the limb with the slow motion in altitude until *A C* is also tangent.

DATE—21st November, 1881—3.18 P.M.
PLACE—2nd base line—50 chs. W. of N.E. corner section 31, R. 14 W. of 3rd meridian.

CIRCLE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE
R	6° 44' 00"	323° 07' 00"	184° 35' 30"
L	6 50 00	322 12 00	184 36 30
Mean.	6 47 00	322 39 30	184 36 00

GREENWICH TIME.

Local time=November 21	....	3h. 18m.
Longitude	... .	7. 08.
Greenwich time=November 21	.....	10. 26.

Correction of altitude.

Obs. altitude	=6° 47' 00"	
—Refraction	=	7.38
Difference	=6° 39' 22"	
Parallax	=	9
h	=6° 39' 31"	

Sun's Polar Distance.

Decl. at 0h	=20° 01' 35"
Var. for 10h. 26m.	=+ 5 ·42
Decl. at 10h. 26m.	=20° 07' 17"
△	=110° 07' 17"

h	=	6°	39' 31"
φ	=	49	20 58
△	=	110	07 17
2S	=	166	07 46
S	=	83	03 53
S—△	=	27	03 24

sec. h	= 0·00294
sec. φ	= 0·18612
cos. S	= 9·08188
cos. (S—△)	= 9·94966
$\cos. \frac{z}{2}$	= 19·22060
$\cos. \frac{z}{2}$	= 9·61030

$\frac{z}{2}$	=	65°	56' 30"
z	=	131	53 00
Az	=	228	07 08
H. C. R. on Sun	=	322	39 30
North point	=	94	32 30
H. C. R. on line	=	184	36 00
Az. of line	=	90	03 30
Az. by account	=	90	02 51
Error	=		39"

DATE—June 15th, 1881—7.20 A.M.
PLACE—8th base line—25 chs. W. of N.E. corner section 36, R. 17, W. of 2nd meridian.

CIRCLE.	SUN'S ALTITUDE.	H. C. R. ON SUN.	H. C. R. ON LINE.
R	29° 50′	175° 43′	176° 38′ 00″
L	30 34	176 51	176 40 00
Mean.	30 12	176 17	176 39 30

GREENWICH TIME.

Local time=June 14	19*h.*	20*m.*
Longitude	6	57
Greenwich time=June 15	2	17

Correction of altitude.

Obs. altitude=30° 12′ 00″	
—Refraction =	1 .40
Diff.	30 10 .20
+Parallax =	8
h =	30. 10 .28

Sun's Polar Distance.

Decl. at 0^h =	23° 20′ 16″ N.
Var. for 2^h 17^m =	+ 14
Decl. at 2^h 17^m =	23 20 30
△ =	66 39 30

h =	30° 10′ 28″
φ =	51 26 45
△ =	66 39 30
2*S* =	148 16 43
S =	74 08 21
S—△ =	7 28 51

Sec. *h* =	0.06324
Sec. φ =	0·20533
cos. *S* =	9·43661
cos. (*S*—△) =	9·99629
cos. $^2\frac{z}{2}$ =	19·70150
cos. $\frac{z}{2}$ =	9·85075

$\frac{z}{2}$ =	44° 50′ 00″
z or *Az* =	89 40 00
H. C. R. on sun =	176 17 00
North point =	86 37 00
H. C. R. on line =	176 39 30
Az. of line =	90 02 30
Az. by account =	90 03 08
Error =	38″

The reading of the horizontal circle on the reference object, generally one of the line pickets, should be taken in both positions of the instrument, and the approximate time of observation noted.

The best time for observation is when the sun is near the prime vertical, that is to say nearly due east or west.

Reduction of observations. The following formula is the simplest that may be used for the calculation:

$$\cos. \tfrac{1}{2}z = \sqrt{\cos S \cos (S-\triangle) \sec \phi \sec h}$$

$$\text{where } S = \frac{h+\phi+\triangle}{2}$$

h being the true altitude of the sun, ϕ the latitude, $\triangle$ the sun's polar distance, and z the angular distance between the sun and the north point. Reckoning the azimuth from 0° to 360° from the north point through east, south and west, z is the azimuth in the forenoon and 360° minus the azimuth in the afternoon.

The latitude and its secant are given in Table V, for the north side of every section.

On pages 56 and 57, two examples are given, one in the afternoon and the other in the forenoon.

Reports and Returns.

The surveyors of township outlines shall send in reports of progress at intervals as nearly monthly as possible, such reports being accompanied by sketches on the scale of one-half mile to the inch, showing the work done and the character of the country, in the manner directed for block surveyors.

These sketches shall exhibit the length of every quarter-section line when different from 40 chains. Such information is also to be sent directly by the township outline surveyor to the subdivider, when requested by the latter.

The final returns of the survey are the same as for block surveys, with the exception of the record of the astronomical observations, which is not required.

APPENDICES.

APPENDIX A.

ACCOUNTS OF SURVEYORS UNDER DAILY PAY.

Surveyors who are employed by the day, will receive, before leaving for their surveys, advances sufficient to procure their outfit and supplies.

When a payment on account is applied for, a statement must accompany the requisition, showing, in detail, how the moneys received were employed and *what expenses the money applied for is to meet.*

No draft on the Department, or order, or power of attorney for moneys on account of the survey will be accepted until the returns of the survey have been examined and approved.

At the end of the survey, the horses and outfit will be left in charge of the Government contractor or disposed of according to instructions.

Surveyors are particularly requested not to store or leave any part of their outfit at other places than the survey depot, as, in most cases, it has been found that articles stored in that manner had to be abandoned. Should it be impossible to bring the whole outfit to the depot, it is better to sell for whatever price may be obtained.

The accounts are to be in duplicate, and the original and duplicate must be exactly alike in all respects and made up in separate bundles.

Each is to consist of:—

1st An account of personal services and allowances.

2nd A pay list of party, showing the date of engagement and discharge of every man, his occupation and rate of pay, and the number of rations for the party. It must be signed by each of the men.

3rd A transport account, with vouchers duly numbered, accompanied by a separate and detailed statement of travelling expenses.

4. A camp equipage account.

5. A stationery account.

6. A balance sheet showing on the credit side the gross amounts of personal services, pay list, transport, camp equipage and stationery accounts and on the debit side the payments received on account of the survey.

Each of the accounts is to have its vouchers attached and statements of sales, if any, attested by the purchasers.

The vouchers must give the detail of articles purchased, with the price of each.

The items of travelling expenses, camp equipage and stationery, for which specific amounts are allowed, are to be charged each in one lump sum, without giving details or vouchers, except, however, for travelling expenses of assistant for which a receipt from the assistant is required.

ALLOWANCES TO SURVEYORS.

Service.	Number or Quantity.	$ cts.
Personal Services and Allowances.		
Salary of Surveyor in charge, per diem		
Ration allowance in the field do	1	
do at office work do	1	1 00
Pay-list.		
Assistant, per diem	1	
Chainmen do (if allowed by instructions)	2	1 20
Cook do	1	1 25
Laborers do		1 00
Ration allowances, per diem		
Transport.		
Horses		
Buckboard		
Carts		
Cart covers		
Setts of harness		
Hobbles		
Horse bells		
Oats and horse-keeping		
Leather, twine, oil, for repairing harness, horse shoes, axle grease		
Freight and storage, west of Winnipeg		
Travelling, freight and all other expenses of Surveyor in charge, east of Winnipeg		160 00
Travelling and other expenses of Assistant, east of Winnipeg		75 00
Travelling expenses of party, west of Winnipeg		
Rebate on provisions (if allowed by instructions)		
Camp Equipage and Plant.		
All articles, tents included		
Stationery.		
All articles		15 00

APPENDIX B.

CONTRACT SURVEYS.

The subdivision of townships is to be made, according to law, at certain rates per mile. These rates are generally determined in advance for each township.

Where not so fixed, the mileage will be classified as follows:—

1st Class—Any land not classified as second or third class.

2nd Class—Poplar, and other soft woods, where occurring in alternation with prairie.

3rd Class—Contracts composed of townships all woods, and wherever they occur, heavy underbrush, hard woods, windfalls, thick willows.

Traverse lines will be classed for pay similarly to the principal lines of the survey, except in prairie or on ice, where they will be paid for at second-class rate.

Nothing will be paid for trial lines, for offsets or for triangles.

In addition to the above rates, the surveyor will receive:—

Fifty cents for each description of settler's improvements.

Fifty cents for taking the affidavit of occupation of each settler.

Two dollars per mile above regular rates for lines posted across river lots..

The description of settler's improvements referred to here, is that contained in the statutory declaration.

It is to be clearly understood that the above prices are to include the making of plans, field-notes, reports, &c. as well as the cost of survey. Nothing will be paid for lines the mounding of which is not completed.

Should the number of offsets, in a traverse, be insufficient to determine properly the line surveyed or, more generally, should any part of the work not be performed in accordance with the instructions, a deduction representing the value of the work omitted will be made from the contract rates.

A surveyor, upon obtaining a contract, will be required to enter into a bond, jointly with two securities, in a sum equal to the estimated amount of his contract, for the due and faithful fulfilment thereof.

Surveyors will receive, with their contract, blank books for field use, blanks of progress accounts, statutory declarations, oath of chainmen and township sketches.

Blank books for office copies of field-notes, skeleton township plans, timber plans and reports and forms of general account will be supplied on the application of the surveyor,—stating the number of each required. It is recommended that such blanks should only be applied for at the time they are required for use, as, when carried in the field, they are liable to be spoiled.

Iron posts will be supplied free of cost, provided they are all used on the survey. Those not so used will have to be returned to the survey depot, otherwise they will be charged for at the rate of 25c. each.

Steel dies to mark the tin squares on the posts will be supplied on application at the head office at the rate of $5.00 per set.

The lines embraced in any survey under contract must be run by the surveyor in person, and no payment will be made on such contract work if otherwise performed.

A rigid inspection of the work will be made. On satisfactory evidence of any impropriety or unfaithfulness in the execution of a contract being reported to the Department, the survey will be cancelled and steps taken at once to recover from the surveyor or his sureties.

On receipt of the bond, properly executed, from a surveyor to whom a contract has been given, an advance of $200 will be sent to his address, and a further advance of $1,300 on account of contract, will be placed in the Bank of Montreal at Winnipeg, payable there to himself in person.

Eighty-five per cent on account of the work performed will from time to time, be paid to the contractor or be placed to his credit, as he may direct. Such payments will be made on receipt of the progress accounts accompanied by sketches of the work. Credits may be telegraphed to the Bank of Montreal, if urgently required, but only after receipt of the sketches.—*No sketches, no money.*

All payments are made by cheques, issued either in favor of the payee, or in favor of the Bank of Montreal to be placed to the payee's credit. It is therefore useless to ask that bank bills be sent instead of cheques or that the money be placed to the surveyor's credit with another firm than the Bank of Montreal, unless the surveyor has previously ascertained that the firm will accept Departmental cheques.

When a payment on account is applied for, the letter should state whether a cheque is wanted or a credit, and where.

It is of the utmost importance that the Department should be kept well informed of the surveyors' post office addresses. Every letter sent should state where the answer is to be forwarded to. Particular attention is called to this matter, as

the most vexatious delays, due to this cause, are continually occurring, and surveyors are the first to suffer therefrom.

FORM OF SURVEY CONTRACT.

THIS AGREEMENT, made the *second* day of *April*, 1883, between *John Frederick Smith*, of the *city* of *York* in the *County of Armagh*, in the Province of *Ontario*, in the Dominion of Canada, Dominion Land Surveyor, hereinafter called the contractor, of the first part, and Her Majesty the Queen, represented herein by the Minister of the Interior of Canada, of the second part;

Witnesseth, that the contractor covenants with Her Majesty, Her Successors and Assigns, that in his own proper person, but with the aid of such chainman and assistants as may be necessary, he will, in strict conformity with such instructions as he may receive from the Minister of the Interior, the Surveyor-General, or other proper officer in that behalf, well, truly and faithfully and to the satisfaction of the Minister of the Interior, perform the following surveys, viz:—

1. *Subdivision of townships twenty-five and twenty-six in ranges six, seven and eight, west of the fourth Initial Meridian*, and any additional survey which may, with his consent, be added to the above surveys.

2. That he will commence the survey on or before the first day of July, A.D. 1883, and will complete the surveys in manner aforesaid and return the plans and the true field-notes, duly sworn to, and other returns of the surveys required, to the Department of the Interior in Ottawa, on or before the first day of April, A.D. 1884.

3. That all chainmen and other assistants required for the survey and other expenses connected therewith, are to be provided and paid for by the contractor.

4. That the contractor will report progress of the surveys to the Inspector of Surveys, in accordance with such instructions as may be given in that behalf.

6. That upon completion of the said surveys by the contractor in strict accordance with the terms of this agreement and to the satisfaction of the Minister of the Interior, and upon receipt by the Department of the Interior at Ottawa of the said plans, field-notes and other returns of surveys, Her Majesty will cause the contractor to be paid at the rates fixed by the Order in Council, dated the 23rd of March, 1883.

The number of miles actually run and marked in the field only to be paid for, random lines, bases of triangles and offsets not to be included. Main traverse lines of lakes, navigable

rivers, or settler's improvements, as shown in the field-notes, to be paid at traverse lines rates.

7. That the contractor shall not assign this contract or any interest therein, and no payment shall be made for any surveys not executed by the contractor personally, assisted as aforesaid.

8. That should the contractor make default in commencing the survey on or before the date above fixed in that behalf, or should he fail to report progress of the surveys as above provided for, or should he fail to complete the surveys in manner above provided for or to return the said plans, field-notes and other returns within the time above limited in that behalf, the Minister of the Interior, Surveyor-General, Inspector of Surveys or other proper officer in that behalf, may procure the work hereby contracted for or any part thereof to be performed by the contractor, or any part thereof to be performed by others, in which case the contractor shall pay and make good to Her Majesty, Her Successors or Assigns, all damages, losses, costs, charges and expenses to which She may be put by reason of the contractor's default and by reason of having to procure the work to be performed by others, including any advances on account made to the contractor and any excess in the cost of such work over the contract price herein specified

9. That Her Majesty may cause advances to be made to the contractor from time to time during the progress of the works on account of the price thereof; but until the completion of the survey and receipt of the plans, field-notes and other returns as provided for, the contractor shall not become entitled to any payment, and if any such advances be made, they shall be considered as a loan to the contractor to be returned to Her Majesty, in case the contractor make default in carrying out any of the terms of this contract.

10. That should the surveys above mentioned and other surveys added as aforesaid, be completed in accordance with the terms of this contract, and the plans, field-notes and other returns be returned to the Department on or before the first day of January, A.D. 1884, Her Majesty will cause to be paid to the contractor as a bonus over and above the contract price, a sum of money equal to fifteen per cent. of the total contract price for the work hereby contracted for.

In witness whereof, the contractor has hereto set his hand and seal, and the Minister of the Interior has signed and sealed these presents on behalf of Her Majesty.

Signed, sealed and delivered in presence of *J. A. McLeod.*

John F. Smith,
Dominion Lands Surveyor.

A. R. Stewart,
Deputy of the Minister of the Interior.

FORM OF BOND.

THIS INDENTURE made the *second* day of *April*, A. D. 1883, between *James William Brown*, of the *Town of Essex*, in the County of *Westmoreland*, in the Province of *Ontario*, in the Dominion of Canada, *Merchant*, and *Richard Alexander Green*, of the *City of Victoria*, in the County of *Wolfe*, in the Province of *Ontario*, in the Dominion of Canada, *Farmer*, of the first part, and Her Majesty the Queen, represented herein by the Minister of the Interior of Canada of the second part;

Witnesseth, that as sureties for the faithful performance by the contractor of the foregoing contract, the parties of the first part covenant with Her Majesty, Her Successors and Assigns that the said contractor will, at or within the time or times and in the manner limited and provided by the said contract, well, truly and faithfully commence, carry on and complete the surveys contracted for in said contract, and report progress thereof and return the plans, field notes and other returns mentioned in the said contract; and further, that should the said contractor fail or make default in any of these respects and should the work or any part thereof be performed by others under the provisions of the said contract, then the said contractor shall pay and make good to Her Majesty, Her Successors or Assigns, all damages, losses, costs, charges and expenses to which she may be put by reason of the contractor's default and by reason of having to procure the work to be performed by others, including any advances on account made to the contractor and any excess in the cost of such work over the contract price herein specified; and further generally, that the said contractor shall and will from time to time and at all times well, truly and faithfully perform, keep and abide by all and singular the covenants, agreements and conditions in the said contract contained and on his part to be performed, kept and abided by.

In witness whereof, the parties hereto have hereunto set their hands and seals.

Signed, sealed and delivered in presence of
G. A. Jones.
as to the signatures of
J. W. Brown, and *R. A. Green*,

Rob. MacFarlane.
as to the signature of *R. A. Green*,

His
J. W. × *Brown*, [L. S.]
Mark.
Surety.

R. A. Green, [L. S.]
Surety.

AFFIDAVITS.

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *James William Brown*, one of the sureties, in the foregoing Bond named, make oath and say as follows:

1. I am seized and possessed to my own use of real and personal estate in the Province of *Ontario*, in Canada, of the actual value of *Two thousand* dollars over and above all charges upon, or encumbrances affecting the same.

2. My Post Office address is as follows:

Essex, County of Westmoreland, Ont.

Sworn before me, at the *City of York*, in the County of *Armagh*, in the Province of *Ontario*, this *second* day of *April*, A. D. one thousand eight hundred and eighty *three*. } *His* *J. W.* × *Brown*, *Mark.*

W. F. Wilson, a J. P. for the said County.

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *Richard Alexander Green*, one of the sureties, in the foregoing Bond named, make oath and say as follows:

1. I am seized and possessed to my own use of real and personal estate in the Province of *Quebec*, in Canada, of the actual value of *Two thousand* dollars over and above all charges upon, or encumbrances affecting the same.

My post office address is as follows:

303 *Main Street, Victoria, County of Wolfe, Ont.*

Sworn before me, at the *City of York*, in the County of *Armagh*, in the Province of *Ontario*, this *second* day of *April*, A. D. one thousand eight hundred and eighty-*three*. } *R. A. Green*,

W. F. Wilson, a J. P. for the said County.

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *John Alexander McLeod*, of the *Township of Lennox*, in the County of *Queen's*, in the Province of *Nova Scotia*, *Merchant*, make oath and say, that I was personally present and did see *John Frederick Smith*, the contractor in

the foregoing contract named, duly execute the said instrument by signing, sealing, and, as his act and deed, delivering the same; and that I am a subscribing witness to such execution.

Sworn before me at the *City of York*, in the said County of *Armagh*, this *second* day of *April*, one thousand eight hundred and eighty-*three*. *W. F. Wilson*, a J. P. for the said County. } *J. A. McLeod.*

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *George Arthur Jones*, of the *Village of Cumberland*, in the County of *Derby*, in the Province of *Manitoba*, *Clerk*, make oath and say, that I was personally present and did see *James William Brown*, the obligor in the foregoing contract or writing obligatory named, duly execute the said instrument by signing, sealing, and, as his act and deed, delivering the same; and that I am a subscribing witness to such execution.

Sworn before me at the *City of York*, in the said County of *Armagh*, this *second* day of *April*, one thousand eight hundred and eighty-*three*. *W. F. Wilson*, a J. P. for the said County. } *G. A. Jones.*

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *George Arthur Jones*, of the *Village of Cumberland*, in the County of *Derby*, in the Province of *Manitoba*, Clerk, make oath and say, that I was personally present and did see *Richard Alexander Green*, the obligor in the foregoing contract or writing obligatory named, duly execute the said instrument by signing, sealing, and, as his act and deed, delivering the same; and that I am a subscribing witness to such execution.

Sworn before me at the *City of York*, in the said County of *Armagh*, this *second* day of *April*, one thousand eight hundred and eighty-*three*. *W. F. Wilson*, a J. P. for the said County. } *G. A. Jones.*

PROVINCE OF *Ontario*, *County of Armagh*, TO WIT: } I, *Robert McFarlane*, of the *Township of Colborne*, in the County of *Hastings*, in the Province of *Quebec*, *Farmer*, make oath and say, that I was personally present and did see *Richard Alexander Green*, the obligor in the foregoing contract or writing obligatory named, duly execute the said

instrument by signing, sealing, and, as his act and deed, delivering the same; and that I am a subscribing witness to such execution.

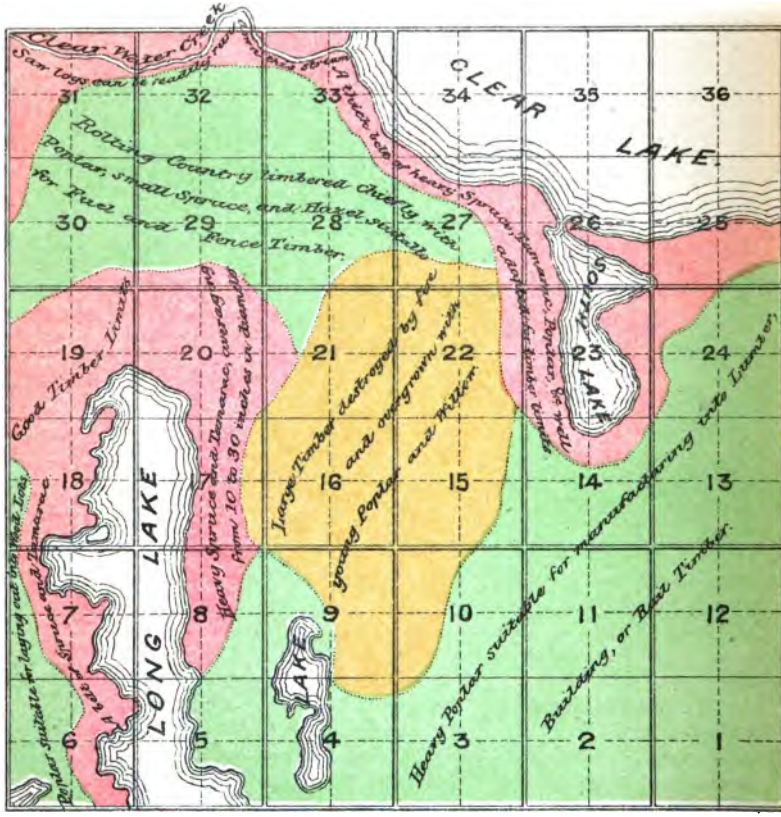
Sworn before me at the *City of York*, in the said County of *Armagh*, this *second* day of *April*, one thousand eight hundred and eighty *three*. } *R. McFarlane.*

W. F. Wilson, a J. P. for the said County.

Specimen of Timber Plan.

TOWNSHIP Nº 19.

RANGE 19 WEST OF MERIDIAN


Clear Water Creek
Saw logs can be readily run down this stream
A River line of heavy Spruce, Tamarac, Poplar & Birch timber
CLEAR LAKE
Rolling Country timbered chiefly with Poplar, small Spruce, and Hazel, suitable for Fuel and Fence Timber.
Good Timber Limits
LONG LAKE
Heavy Spruce and Tamarac, average from 10 to 30 inches in diameter
Large Timber destroyed by fire and overgrown with young Poplar and Willow
Heavy Poplar suitable for manufacturing into Lumber
Bastard, or Rock Timber.
Timber suitable for laying out into Wood Lots
31 32 33 34 35 36
30 29 28 27 26 25
19 20 21 22 23 24
18 16 15 14 13
7 8 9 10 11 12
6 5 4 3 2 1

REFERENCES.

Spruce. Poplar. Oak.

APPENDIX C.

Specimen Timber Report.

Township 19, *Range* 19, *West of* *Meridian.*

This township is covered entirely with a growth of timber, which, for the purposes of description, may be divided into three divisions, viz:—

1st. Timber suitable for the manufacture of marketable lumber.

2nd. Building and fence rail timber.

3rd. Timber for fuel only.

The 1st division comprises the lands bordering on Long Lake, Clear Lake and Clear Water Creek; these are covered chiefly with heavy spruce and tamarac averaging in size from 10 to 30 inches in diameter, generally sound, and running up to a height of 50 to 60 feet. Clumps and ridges of poplar are also found; these trees are, however, generally unfit for manufacturing into lumber, owing to their being rotten at the heart. The timber adjoining the Clear Water Creek and the north end of Long Lake, viz:—on parts of sections 31, 32, 33, 17, 18, 19, 20, I consider the most valuable on account of its superior quality and size.

The timber in the northerly sections can be readily driven down the Clear Water Creek to the Little Saskatchewan in the spring, and that bordering on Long Lake could be run down the Rolling River, which flows out of the the south end of this lake and joins the Little Saskatchewan, near the 5th base. I would recommend that the land in the 1st division should be reserved from sale and settlement and set apart to be licensed as timber limits.

2nd Division.—As the lands to the south of this township are well adapted for settlement, this being evidenced by the fact that a number of settlers have taken up homesteads in the townships adjoining, the lands in this division, especially sections 1, 2, 3, 4, 10, 11, 12, should be set apart to be divided into wood lots of not more than 20 acres each, and sold to the settlers as they are required.

3rd Division.—The central portion of the township is almost entirely covered with windfall.

The timber, as it lies at present, is well suited for fuel, being quite dry and sufficiently elevated above the ground to prevent immediate decay. I would recommend that permits be given to settlers who may apply for them, to cut fuel to supply their needs on the sections shown, as covered with windfall, on the accompanying plan.

APPENDIX D.

FORM OF ENGAGEMENT.

ARTICLES OF AGREEMENT, made and entered into at *Winnipeg*, this *fifth* day of *June*, A. D. 1883, between *John Frederick Smith*, of the *City of York*, in the Province of *Ontario*, Dominion Land Surveyor, and *Andrew Gordon*, of the *City of Winnipeg*, in the Province of *Manitoba*.

Witness that the said *Andrew Gordon* agrees with the said *John Frederick Smith*, to faithfully and diligently serve him, and his assistant or assistants, or any person under whose charge the said *Andrew Gordon* may for the time being, be placed by order and direction of the said *John Frederick Smith*, as *laborer*, from the date of this agreement, until the said *John Frederick Smith* shall have completed his survey.

In Consideration Whereof, the said *John Frederick Smith*, agrees to pay the said *Andrew Gordon* at the rate of *one dollar* per diem, and to board him so long as the said *Andrew Gordon* continues to serve under this agreement.

And it is agreed between the parties hereto that the provisions of Ordinance number Five of 1879, of the Lieutenant Governor in Council of the North-West Territories, shall apply to the same under this agreement, payment in full to be made only after fulfilment of the engagement by the said *Andrew Gordon*, and the performance by him of his part of this agreement.

In Witness Whereof the parties hereto have hereunto set their hands the day and year first above written.

Signed in presence of }
E. D. Johnson. }

Andrew Gordon,
John F. Smith,
Dominion Land Surveyor.

APPENDIX E.

ORDINANCES OF THE NORTH-WEST TERRITORIES.

No. 5 of 1879.

An Ordinance respecting Masters and Servants.

(*Passed 26th September*, 1879.)

Be it enacted by the Lieutenant-Governor of the North-West Territories, in Council, as follows:—

I. Every contract of hire for personal service for any period more than a year shall be in writing, signed by the contracting parties.

II. Any person engaged, bound or hired, whether as a clerk, journeyman, apprentice, servant, laborer, or otherwise howsoever, guilty of ill behavior, drunkenness, refractory conduct or idleness,—of absenting himself by day or night without leave, from his proper service or employment, or from the house or residence of his employer, of refusing or neglecting to perform his just duties, or to obey the lawful commands of his master,—of dissipating his employer's property or effects, or of any unlawful act that may affect his employer's interests,—shall, upon being convicted of any or either of the said offences, before any justice of the peace, for every such offence forfeit and pay such sum of money not exceeding thirty dollars as to the said justice seems meet, together with costs of prosecution; and in default of payment thereof, forthwith be imprisoned for any period not exceeding one month, unless the fine imposed and costs, together with the costs of commitment and conveying such person convicted to the place of imprisonment, be sooner paid.

III. Any person convicted before any justice of the peace of harboring or concealing any apprentice or servant who has deserted his master's service, or instigating any such apprentice or servant to desert such service, or of keeping such apprentice or servant in his service after being notified or informed of the fact, shall be liable to the same penalties as are enacted in the next preceding section of this Ordinance.

IV. It shall be lawful for any justice of the peace, on complaint on oath by any employee or other servant, of ill usage,

non-payment of wages (not exceeding two month's wages, the same having been first demanded), or improper dismissal by his master or employer, to cause such master or employer to be brought before him, and upon proof to his satisfaction of the complaint being well founded, to order such complainant to be discharged from his engagement, and to order such master or employer to pay such complainant one month's wages in addition to the amount of wages then actually due him, not exceeding two month's wages as aforesaid, together with the costs of prosecution, the same to be levied by distress and sale of the offender's goods and chattels; and in default of sufficient distress, imprisoned for any term not exceeding one month, unless the said moneys and costs be sooner paid.

V. The provisions of this Ordinance shall be held to apply in the North-West Territories to contracts and agreements made at any place outside the same.

VI. On the trial of any complaint made under this Ordinance, the complainant and accused shall be admitted to give evidence.

VII. Nothing in this Ordinance shall in any wise curtail, abridge or defeat any civil or other remedy for the recovery of wages or damages, which employers or masters may have against servants or employees, or which servants or employees may have against their masters or employers.

VIII. Prosecution for offences under this Ordinance shall be commenced within three months after the offence has been committed, and not after.

IX. Any Ordinance heretofore in force in the North-West Territories respecting masters and servants is hereby repealed

PRICES AND WEIGHTS OF PROVISIONS.

Articles.	Quantity required by one man for 30 days.*	Winnipeg quotations, 20th June, 1883.	How packed.	Weight of package.
Flour	40 lbs.	XXXX or Strong Bakers, $2.50; XXX, $1.90.....	strong s'ks	98 lbs. net flour.
Oatmeal.....	3 "	Standard, $7.00 per brl. ...	In barrels.	196 "
Cornmeal ...	3 "	Kiln dried, $2.75 per sack.	In sacks...	98 "
Bacon	20 "	Smoked, clear sides, 15c....	In cases or sacks....	{cases about 500 {Sacks " 150
Ham.....	8½ "	Canvassed, 15½c.	In crates or sacks....	{Crates " 400 {Sacks " 150
Butter	6½ "	Choice Dairy, 22c	Tubs	About 60 lbs.
Cheese	2½ "	Choice No. 1, 15½c.	Boxed	" 58 "
Beans	5 "	Med. hand picked, $2.75 per bush., or 5c. per lb.....	brls.or s'ks	{Brls. about 250 {Sacks " 100
Vegetables..	1½ "	Compressed Chollets, 55c.; American, 45c.....	In tins	4 lbs.
Apples, dried	5 "	Choicest N.Y. sliced, 12c...	In barrels.	About 220 lbs.
Sugar, lump	9½ "	Paris Lump, 11½c.....	In boxes...	50 lbs.
Coffee	1½ "	{Fine ground Rio, 22c.. {" Java, 30c	" ...	20 and 25 lbs.
Tea	1 "	{Black, 22½c. to 40c., according to quality. ..... {Japan, " " "	H'f-chests	50 and 60 lbs.
Syrup	3 pints	Bright, per keg. $3.25.....	In kegs.....	52 lbs.
Vinegar	½ pint	Barrels, per gall., 40c. gall; 5 demijohn, $3.00.	Brls.or demijohns	{Brls., 500 lbs. {D'johns, 55 lbs
Baking Powder....	1 lb..	Dr. Price's, 45c.; Snowdrift, 25c. per lb..	In tins	1, 4 or 5 lbs.
Yeast, Gems	1 cake	Price's Lupulin, 7c. per pkge. of 10 cakes.....	3doz.inbox	About 20 lbs.
Pepper, Gr'd	1¼ oz.	Ground Black, 16c. per lb.	In boxes ..	10 and 20 lbs.
Mustard	1 "	Common, 17c.; Keen's, 25c. per lb.....	In boxes and tins	Box 10 lbs., tin 10 lbs.
Salt	2⅛ lbs	Dairy, in bags, 9c. per bag	Bags	5 lbs.
Ess. Lemon.	1½ oz.	Extra quality, 2 oz. bottles, $2.00 per gall.....	1 g. boxes	3 "
Pickles	1½ pts	$2.50 to $2.75 per doz. bottles.	Cases& b's	{Cases, 75 & 100 lbs. {Brls., 170 lbs.
Candles	1 lb	Star, full wgt. 16ozs., 20c. per lb	In boxes...	40 lbs.
Matches	⅛ box	50c. per gross pkgs.....	10 gr. cases	60 "
Soap.....	2 lbs.	Savon superfin, $3.50 per box of 60 bars.....	In boxes...	50 "

*Taken from the instructions to Land Examiners issued by the Canadian Pacific Railway—some of the articles, such as butter, etc., are not adapted to the requirements of a party organized for the survey of Dominion Lands.

TABLES.

EXPLANATION

OF THE TABLES.

The elements of the figure of the earth on which the geodetic tables are based are those given by Capt. A. R. Clarke in his "Comparisons of Standards of Length, &c., 1866."

These elements are:—

Equatorial semi-axis $= a = 6378206.4$ metres.

Polar semi-axis $= b = 6356583.8$ metres.

His value of the metre (which has also been used) is 39·370432 inches.

TABLE I.

The first column of this table gives the argument—the latitude of the place.

With this argument the second column gives the logarithm of the length of, N sin 1″, in Gunter's chains, *i.e.*, of one second (1″) of the great circle of the earth perpendicular to the meridian of the place.

The third column gives the logarithm of the length in chains of P sin 1″, *i.e.*, of one second (1) of longitude.

The fourth column gives the logarithum of R sin 1″, *i.e.*, of one second (1″) of latitude.

These values have been used in computing the following tables.

TABLE II.

The argument in this table is the number of the base or correction line, or (in the first column) the number of townships intervening between the 49th parallel of latitude and the line.

The next column contains the latitude of the line, and the next three columns give log N sin 1″, log P sin 1″, and log R sin 1″ as before.

The last column of the table gives the difference of longitude between two points on the line 486 chains apart.

For interpolating, in this table and in Table 1, the logarithm of N sin 1″, P sin 1″ and R sin 1″, for any latitude intermediate between the latitudes of the table, N sin 1″, and R sin 1″ may be interpolated directly, in the usual way, by first differences, but to obtain P sin 1″ for an intermediate latitude, it is necessary, if accuracy be required, to first inter-

polate N sin 1" for the latitude, and then to multiply the result by the cosine of that latitude.

For $$P \sin 1'' = N \sin 1'' \times \cos \phi.$$

TABLE III.

This table gives for the argument—number of the base line: first, the chord azimuth, *i. e.*, the angle, in degrees, minutes and seconds, measured from the north towards the west, which a township chord makes with the meridian. In the next column is given the same angle, in degrees and decimals of a degree.

The two columns headed "Deflection" give the angle between one chord produced and the next one; or 180° less twice the chord angle. One column gives it in minutes and seconds, and the other in decimals of a degree. The "Deflection Offset" is the tangent subtended by this deflection angle at a distance of one chain.

In the column headed "Longitude for one range" is given the number of seconds to be added to or subtracted from the time shown by a chronometer to correct it for the difference of longitude between one corner of a township and the other. In other words, if a watch or chronometer be carried across a township it will be that number of seconds slower or faster, if it has no gaining or losing rate of its own.

TABLE IV.

This table gives for correction lines the chord azimuths, deflections and deflection offsets for running the chord along the *south* side of the road allowance.

The table also gives the length of one range on the *north* and *south* sides of the road allowance. The length on the north side is the distance included on the correction line, between two meridians from the base next north of the correction line. The longitude covered by this length is of course the same as that covered by one range on the next base north, and is given in the last column of Table III. Similarly for the south side.

The difference between the lengths of one range on the north and south sides of the road allowance is the "jog."

Half the jog is very nearly the narrowing or extension of one range in going north or south from a base to a correction line.

One twenty-fourth of the jog is the "convergence or divergence" of the meridians for one quarter-section on the correction line; this should be the difference from forty chains of every quarter-section: For the township line mid-way between

the base and correction line, half of this quantity is to be taken.

TABLE V

Gives the latitude, the logarithms of its secant and tangent and the width of quarter-sections for the north side of every section. The logarithms of secant and tangent ϕ are given to simplify the calculation of the azimuth formula (page 46.) The width of quarter-sections is what it would be, were the survey perfectly correct.

TABLE VI

Is intended to facilitate the observation of the pole star in strong daylight, by placing the telescope precisely in the direction of the star. The second column gives the approximate azimuth at different times and for townships 0 to 80. The last column contains the distance of Polaris above or below the pole, which added to or subtracted from the latitude, gives the approximate altitude.

TABLE VII

is for determining the watch error by the observation, at any time, of the transits of Polaris and another star across the same vertical plane.

Let ϕ be the latitude of the place, α' and δ' the right ascension and declination of Polaris, α and δ the same quantities for the other star, and T' and T the chronometer times at which each of the stars was respectively observed to cross the same vertical. Let p be the arc of the great circle perpendicular to the meridian and comprised between the pole star and the meridian.

The hour angle of the time star, at the instant it was observed, was equal to

$$t = p\ (\tan \phi - \tan \delta)$$

which, when p is known is easily calculated by taking (tan. ϕ—tan. δ) from a table of natural tangents to three places of decimals. Were no such table at hand the following logarithmic form of the same formula could be employed:

$$t = p\ \frac{\sin\ (\phi - \delta)}{\cos \phi \cos \delta}$$

For stars below the pole the formula would be:

$$t = p\ (\tan \phi + \tan \delta)$$

or

$$t = p\ \frac{\sin\ (\phi + \delta)}{\cos \phi \cos \delta}$$

Table VII. gives the values of p computed for the mean declination.

$$88° 41' = 88°.6833.$$

For any other value of δ', p must be multiplied by

$$\frac{\cos \delta'}{\cos 88° 41'}$$

The logarithm of the above factor is very simply found by adding

1·63857

to log. tan P given in the annual ephemeris of Polaris.

The arguments of the table are the declination of the time star, δ, and

$$t - t' = (\alpha - \alpha') - (T - T')$$

With carefully adjusted collimation and axis well levelled, the surveyor needs to observe but one star to obtain a chronometer correction sufficiently approximate for azimuth work.

It may be remarked that p, multiplied by the secant of the pole star's altitude gives at once the azimuth at the time of observation:

$$Az = p \text{ sec. } h$$

The table has been computed by the following formula:

$$p = P \sin (t - t') + \frac{P^2}{2} \sin 2 (t - t') \tan$$

Only in exceptional cases will the neglected terms of the development cause an error of one quarter of a second in the time deduced.

The example given will show the calculation by both formulas.

To deduce the chronometer error from the following chronometer times of transit across the same vertical plane.

Polaris..... 6h. 33m. 27s.....15th April 1881.
αCanis Majoris... 6 36 42 ..... do

Chronometer supposed to keep sidereal time without daily rate. Place, 6th base line.

α (Ann. Ephemeris) = 6h. 39m. 55s. 4				$T = 6h.\ 36m.\ 42s.$			ϕ (Table V) = 508.77		
α' do = 1 14 29 8				$T' = 6$ 33 27			δ (an. Eph.) = −16.56		
$\alpha - \alpha' = 5$ 25 25 6				$T - T' =$ 3 3 15			$\phi - \delta = 67\ .33$		
$T - T' =$ 3 15 0									
$t - t' = 5$ 22 10 6									
$\log p$ (Table VII) = 2.49293									

By Natural Tangents.		By Logarithms.	
	Const. log. = 1.63857		Const. log. = 1.6 857
Nat. tan ϕ = 1.2248	log tan P (Ann. Eph.) = 8.36363	log. tan P (Ann. Eph.) =	8.36363
Nat. tan δ = −0.2974	log. p (Table VII) = 2.49293	log. p (Table VII) =	2.49293
tan ϕ − tan δ = 1.5222	log (tan. ϕ − tan. δ) = 0.18247	log. sin. (ϕ—δ) =	9.96508
		log. sec ϕ (Table V) =	0.19897
	log. t = 2.67760	log. sec. δ =	0.01840
	t = 7m. 56s .0		
	= 6 39 55 .4	log. t =	2.67758
Sid. time of transit = 6 31 59 .4		t =	476s .0
	T = 6 36 42 .0		
Chronometer error = — 4 42 .6			

TABLE VIII

Gives chains in decimals of a township side; the average length of north or south sides, viz.: 486 chs. has been used in the computation of the second column of this table.

TABLE IX

Contains the correction to be applied to the normal width of road allowance, to obtain its value at township corners on correction lines. It is to be added to one chain for township corners south of the road, and subtracted for corners north of it.

TABLE X

Gives the logarithm of the ratio of a small arc expressed in seconds of arc, to its tangent; by adding it to the log. tangent, the logarithm of the arc is obtained, and the arc itself is found with a table of logarithms of numbers, without having to compute proportional parts. This table is intended to replace the table printed on the record of astronomical observations, when the instrument employed is divided sexagesimally.

TABLE XI

Is useful in running trial lines. It gives the angular deflection of a line for deviations of one to 149 links at the end of eighty-one chains.

TABLE XII

Is the part of the table of addition and subtraction logarithms, useful in reducing time azimuth observations with Polaris. Suppose two numbers a and b, and $a > b$; then we have, as long as A is less then 10.

FOR SUMS.	FOR DIFFERENCES.
Take $10 + \log. b - \log. a = A$ and then.	Take $\log. a - \log. b = B$ and then.
$\text{Log.}(a+b) = \log. a + B$	$\text{Log.}(a-b) = \log. b + A - 10.$

TABLE XIII

Gives the correction for refraction to be applied to the sun's polar distance when using solar instruments. It is always to be subtracted from the tabular distance.

This table was computed from the following formulas:

$$r = 57'' \text{ cotg. } (\delta + N)$$

$$\text{Tan. } N = \text{cotg. } \Phi \cos t.$$

Where δ is the declination Φ the latitutude and r the refraction.

TABLE I.

LOGARITHMS of the Lengths in Gunter's Chains of certain Geodetic Lines, computed from Clarke's elements of the Figure of the Earth.

Latitude.	Log. N. sin 1''.	Log. R. sin 1''.	Log. P. sin 1''.	Latitude.	Log. N. sin 1''.	Log. R. sin 1''.	Log. P. sin 1''.
° ′				° ′			
49 00	0·1875572	0·1862852	0·0045001	54 40	0·1876988	0·1867100	9 9498763
49 10	5615	2981	0·0030469	54 50	7029	7223	9·9480928
49 20	5657	3107	0·0015849	55 00	7068	7310	9·9462981
49 30	5699	3233	0·0001143	55 10	7110	7466	9·9444925
49 40	5741	3359	9·9986350	55 20	7150	7586	9·9426754
49 50	5784	3488	9·9971470	55 30	7190	7706	9·9408470
50 00	5826	3614	9·9956501	55 40	7230	7826	9·9390072
50 10	5869	3743	9·9941444	55 50	7270	7946	9·9371557
50 20	5911	3869	9 9926296	56 00	7309	8063	9·9352926
50 30	5953	3995	9·9911058	56 10	7349	8183	9 9334177
50 40	5995	4121	9·9895730	56 20	7390	8306	9·9315311
50 56	6037	4247	9·9880309	56 30	7429	8423	9·9296324
51 00	6079	4373	9·9864797	56 40	7468	8540	9·9277216
51 10	6121	4499	9·9849192	56 50	7507	8657	9·9257986
51 20	6163	4625	9·9833493	57 00	7546	8774	9·9238634
51 30	6205	4751	9·9817701	57 10	7586	8894	9·9219158
51 40	6247	4877	9·9801813	57 20	7625	9011	9·9199557
51 50	6288	5000	9·9785829	57 30	7665	9131	9 9179830

TABLE I.—*Concluded.*

Logarithms of the Lengths in Gunter's Chains of certain Geodetic Lines, computed from Clarke's elements of the Figure of the Earth.

Latitude.	Log. N. sin 1″.	Log. R. sin 1″.	Log. P. sin 1″.	Latitude.	Log. N. sin 1″.	Log. R. sin 1″.	Log. P. sin 1″.
° ′							
52 00	0·1876330	0·1865126	9 9769750	57 40	0·1877703	0·1869245	9·9159974
52 10	6372	5253	9 9753574	57 50	7742	9362	9 9139991
52 20	6413	5375	9·9737299	58 00	7781	9479	9·9119378
52 30	6455	5501	9 9720926	58 10	7819	9593	9 9099633
52 40	6497	5627	9·9704455	58 20	7857	9707	9·9079 56
52 50	6538	5750	9 9687582	58 30	7896	9824	9 9058747
53 00	6578	5870	9·9671208	58 40	7934	0·1869938	9·9038102
53 10	6620	5996	9·9654435	58 50	7972	0·1870052	9·9017321
53 20	6662	6122	9 9637559	59 00	8010	0166	9·8996403
53 30	6702	6242	9·9620578	59 10	8048	0280	9 8975347
53 40	6744	6368	9·9603495	59 20	8086	0394	9·8954150
53 50	6785	6491	9·9586307	59 30	8123	0505	9·8932812
54 00	6825	6611	9·9569012	59 40	8161	0619	9·8911331
54 10	6866	6734	9 9551612	59 50	8198	0730	9·8889706
54 20	6907	6857	9 9534104	60 00	8235	0·1870841	9·8867935
54 30	6948	6980	9·9516488				

TABLE II.

Latitudes, &c., of Base and Correction Lines.

Name of Line.	Latitude.	Log. N. sin 1".	Log. P. sin 1".	Log. R. sin 1".	Longitude covered by 486 Chains.	No. of Township.
	° ' "				' "	
1st Base	49 00 00·00	0·1875572	0·0045001	0·1862852	8 00·990	0
Correction	10 29·05	5617	0·0029764	2987	02·681	2
2nd Base	20 58·07	5661	0·0014431	3119	04·388	4
Correction	31 27·08	5705	9·9999603	3251	06·112	6
3rd Base	41 56·08	5749	9·9983480	3383	07·852	8
3rd Correction	52 25·05	5794	9·9967861	3518	09·610	10
4th Base	50 02 54·01	5838	9·9952143	3650	11·385	12
Correction	13 22·96	5883	9·9936329	3786	13·178	14
5th Base	23 51·88	5927	9·9920418	3918	14·988	16
Correction	34 20·77	5971	9·9904407	4050	16·816	18
6th Base	44 49.65	6015	9·9888297	4182	18·662	20
Correction	55 18·51	6059	9·9872086	4314	20·527	22
7th Base	51 05 47·35	6103	9·9855774	4446	22·4 1	24
Correction	16 16·17	6147	9·9839365	4578	24 313	26
8th Base	26 44·98	6191	9·9822842	4710	26 235	28
8th Correction	37 13·76	6235	9·9806224	4842	28·176	30
9th Base	47 42·53	6279	9·9789500	4974	30·136	32
Correction	58 11·26	0·1876322	9·9772671	0·1865103	8 32·117	34

TABLE II.- Latitudes, &c., of Base and Correction Lines.—*Continued.*

Name of Line.	Latitude.	Log. N. sin. 1".	Log. P. sin 1".	Log. R. sin. 1".	Longitude covered by 486 Chains.	No. of Township.
	° ′ ″				′ ″	
10th Base	52 08 39·98	0·1876366	9 9755737	0·1865235	8 34·118	36
Correction	19 08·69	6409	9·9738694	5364	36·139	38
11th Base	29 37·37	6453	9·9721545	5496	38·181	40
Correction	40 06·04	6497	9·9704288	5628	40·245	42
12th Base	50 34·69	6540	9·9686921	5757	42·329	44
Correction	53 01 03·31	6582	9·9669442	5883	44·436	46
13th Base	11 31·92	6626	9·9651855	6015	46·564	48
13th Correction	22 00·52	6670	9·9634156	6147	48·714	50
14th Base	32 29·09	6712	9·9616342	6273	50·887	52
Correction	42 57·65	6756	9·9598417	6405	53·083	54
15th Base	53 26·19	6799	9·9580375	6534	55·302	56
Correction	54 03 54·71	6841	9·9562218	6660	57·545	58
16th Base	14 23·21	6884	9·9543945	6789	8 59·811	60
Correction	24 51·69	6927	9.9525554	6918	9 02·102	62
17th Base	35 20·15	6969	9·9507044	7044	04·417	64
Correction	45 48·59	7012	9·9488415	7173	06·758	66
18th Base	56 17·01	7054	9·9469665	7298	09·123	68
18th Correction	55 06 45·42	7096	9·9450792	7424	11·515	70
19th Base	17 13·82	7139	9·9431798	7553	13·932	72
Correction	27 42·20	0·1877181	9·9412680	0·1867679	9 16·376	74

20th Base	38 10·55	0·1877223	9·9393437	0·1867805	9 18·847	76
Correction	48 38·89	7264	9·9374066	7928	21·345	78
21st Base	59 07·20	7305	9·9354569	8051	23·871	80
Correction	56 09 35·49	7347	9·9334945	8177	26·424	82
22nd Base	20 03·77	7390	9·9315192	8306	29·006	84
Correction	30 32·03	7431	9·9295307	8429	31·618	86
23rd Base	41 00·28	7472	9·9275290	8552	34·258	88
23rd Correction	51 28·51	7513	9·9255140	8675	36·929	90
24th Base	57 01 56·70	7554	9·9234856	8798	39·630	92
Correction	12 24·89	7595	9·9214436	8921	42·362	94
25th Base	22 53·07	7637	9·9193880	9047	45·125	96
Correction	33 21·22	7678	9·9173186	9170	47·919	98
26th Base	57 43 49·36	7718	9·9152351	9290	50·747	100
Correction	54 17·48	7759	9·9131376	9413	53·607	102
27th Base	58 04 45·57	7799	9·9110259	9533	56·500	104
Correction	15 13·66	7839	9·9088998	9653	9 59·427	106
28th Base	25 41·73	7879	9·9067591	9773	10 02·389	108
28th Correction	36 09·78	7919	9·9046039	0·1869893	05 386	110
29th Base	46 37·81	7959	9·9024339	0·1870013	08·418	112
Correction	57 05·83	7999	9·9002490	0133	11·487	114
30th Base	59 07 33·83	8039	9·8980490	0253	14·593	116
Correction	18 01·81	8078	9·8958337	0370	17·735	118
31st Base	28 29·77	8117	9·8936029	0487	20·917	120
Correction	38 57·71	8157	9·8913568	0607	24·136	122
32nd Base	49 25·64	8196	9·8890948	0724	27·396	124
Correction	59 53·55	0 1878235	9·8868170	0·1870840	10 30·695	126

TABLE III.

Chord Azimuths, Deflections, Deflection Offsets, &c., for Base Lines.

Number of Base Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal.	Deflection Decimal.	Deflection Offset for 1 chain distance.	Longitude covered by 1 range.	Number of Township.
	° ′ ″	°	′ ″	°	inches.	s	
1	89 56 58·5	89·9496	6 03·0	0·1008	1·394	32·1	0
2	56·3	·9490	07·5	·1021	1·411	32·3	4
3	54·0	·9483	12·0	·1033	1·429	32·5	8
4	51·7	·9477.	16·6	·1046	1·447	32·8	12
5	49·4	·9471	21·3	·1059	1·465	33·0	16
6	47·0	·9464	26·1	·1072	1·483	33·2	20
7	44·6	·9457	30·9	·1086	1·501	33·5	24
8	42·1	·9450	35·8	·1099	1·520	33·7	28
9	39·6	·9443	40·8	·1113	1·539	34·0	32
10	37·1	·9436	45·9	·1127	1·558	34·3	36
11	34·5	·9429	51·0	·1142	1·578	34·5	40
12	31·9	·9422	56·2	·1156	1·598	34·8	44
13	29·3	·9415	7 01·5	·1171	1·619	35·1	48
14	26·6	·9407	06·9	·1186	1·639	35·4	52
15	23·8	·9399	12·4	·1201	1·660	35·7	56
16	21·0	·9392	18·0	·1217	1·682	36·0	60
17	18·2	·9384	23·7	·1232	1·704	36·3	64
18	15·3	·9376	29·4	·1248	1·726	36·6	68
19	12·4	·9368	35·3	·1265	1·749	36·9	72
20	09·4	·9359	41·3	·1281	1·772	37·3	76
21	06·3	·9351	47·4	·1298	1·795	37·6	80
22	03·2	·9342	53·6	·1316	1·819	37·9	84
23	00·1	·9334	59·8	·1333	1·843	38·3	88
24	89 55 56·9	·9325	8 06·3	·1351	1 867	38·6	92
25	53·6	·9316	12·8	·1369	1·892	39·0	96
26	50·3	·9306	19·5	·1387	1·918	39·4	100
27	46·8	·9297	26·3	·1406	1·944	39·8	104
28	43·4	·9287	33·3	·1426	1·971	40·2	108
29	39·9	·9277	40·3	·1445	1·998	40·6	112
30	36·2	·9267	47·6	·1465	2·026	41·0	116
31	32·6	·9257	54·9	·1486	2·054	41·4	120
32	28·8	·9247	9 02·4	·1507	2·083	41·8	124

TABLE IV.

Chord Azimuths, Deflections, Deflection Offsets, Jogs, &c., for Correction Lines.

Number of Correction Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal.	Deflection Decimal.	Deflection Offset for 1 Chain distance.	Length of one Range on Correction Line.		Jog.	Convergence or Divergence for one half section.	Number of Township.
						N. side of Road.	S. side of Road			
	° ′ ″	°	′ ″	°	Inches.	Chains.	Chains.	Chains	Chains.	
1	89 56 57·4	89·9493	6 05·2	0·1014	1·403	487·719	484 297	3·421	0·143	2
2	55·1	·9486	09·8	·1027	1·420	·740	·276	·463	·144	6
3	52·9	·9480	14·3	·1040	1·438	·762	·255	·507	·146	10
4	50·5	·9474	19·0	·1053	1·456	·781	·233	·551	·148	14
5	48·2	·9467	23·7	·1066	1·474	·806	·212	·594	·150	18
6	45·8	·9461	28·5	·1079	1·492	·829	·188	·641	·152	22
7	43·3	·9454	33·4	·1093	1·510	·852	·167	·685	·154	26
8	40·9	·9447	38·3	·1106	1·529	·875	·144	·731	·155	30
9	38·3	·9440	43·4	·1120	1·548	·899	·120	·779	·157	34
10	35·8	·9433	48·4	·1134	1·568	·923	·097	·826	·159	38
11	33·2	·9426	53·6	·1149	1·588	·947	·072	·875	·161	42
12	30·6	·9418	58·8	·1163	1·608	·972	·047	·925	·164	46
13	27·9	·9411	7 04·2	·1178	1·629	487·997	484·024	3·973	·166	50
14	25·2	·9403	09·6	·1193	1·650	488·023	483·998	4·0·5	·168	54
15	22·4	·9396	15 2	·1209	1·671	·049	·972	·077	·170	58
16	19·6	·9388	20·8	·1224	1·693	·075	·946	·129	·172	62

TABLE IV.—*Concluded.*

CHORD Azimuths, Deflections, Deflection Offsets, Jogs, &c., for Correction Lines.

Number of Correction Line.	Chord Azimuth Sexagesimal.	Chord Azimuth Decimal.	Deflection Sexagesimal.	Deflection Decimal.	Deflection Offset for 1 Chain distance.	Length of one Range on Correction Line.		Jog.	Convergence or Divergence for one-half section.	Number of Township.
						N. side of Road.	S. side of Road.			
	° ′ ″	°	′ ″	°	Inches.	Chains.	Chains.	Chains.	Chains.	
17	89 56 16·7	89·9380	7 26·6	0·1241	1·715	488·102	483·919	4·183	0 17	66
18	13·8	·9372	32·4	·1257	1·737	·130	·892	·238	·177	70
19	10·9	·9364	38·3	·1273	1·760	·158	·865	·293	·179	74
20	07·8	·9355	44·4	·1290	1·783	·187	·837	·350	·181	78
21	04·8	·9347	50·5	·1307	1·807	·215	·809	·406	·184	82
22	89 56 01·7	·9338	56·7	·1324	1·831	·245	·779	·466	·186	86
23	89 55 58·5	·9329	8 03 0	·1342	1·855	·275	·750	·525	·189	90
24	55·2	·9320	09·6	·1360	1·879	·306	·720	·586	·191	94
25	51·9	·9311	16·2	·1378	1·905	·338	·690	·648	·194	98
26	48·6	·9302	22·9	·1397	1·931	·369	·658	·711	·196	102
27	45·1	·9292	29·8	·1416	1·957	·402	·627	·775	·199	106
28	41·6	·9282	36·8	·1436	1·984	·434	·594	·840	·202	110
29	38·0	·9272	44·0	·1456	2·012	·469	·561	·908	·204	114
30	34·4	·9262	51·2	·1476	2·040	·503	·528	4·975	·207	118
31	30·7	·9252	58·6	·1496	2·068	·538	·493	5·045	·210	122
32	89 55 26·9	89·9241	9 06·2	·1517	2·097	488·574	483·458	5·116	·213	126

TABLE V.

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan ϕ	Difference for 10 chains.	Quarter-Section.
	36	49°.0000	0·183 06		0·060 84		40·000
1	1	0147	19		0·061 06		39·988
	12	0291	31		28		976
	13	0438	44		51		964
	24	0582	57		73		953
	25	0729	69		95		941
	36	0874	82		0·062 17		929
2	1	1020	95		40		917
	12	1165	0·184 08		62		905
	13	1311	20		85		893
	24	1456	33		0·063 07		882
	25	1603	46		29		870
	36	1747	59		51		39·858 40·143
3	1	1894	71		74		131
	12	2039	84	0·000 02	96	0·000 03	119
	13	2185	97		0·064 18		107
	24	2330	0·185 10		41		095
	25	2476	23		63		084
	36	2621	35		85		072
4	1	2768	48		0·065 08		060
	12	2912	61		30		048
	13	3059	74		52		036
	24	3203	87		74		024
	25	3350	0·186 00		97		012
	36	3495	12		0·066 19		000
5	1	3641	25		42		39·988
	12	3786	38		64		976
	13	3932	51		86		964
	24	4077	64		0·067 08		952
	25	4224	77		31		940
	36	4369	90		53		928
	1	4515	0·187 03		76		916
	12	4659	15		98		904
	13	4806	28		0·068 20		892
	24	4951	41		43		880
	25	5097	54		65		868

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	36	49°.5242	0·187 67		0·068 87		39·858 40·145
7	1	5388	80		0·069 10		133
	12	5533	93		32		121
	13	5680	0·188 06		54		109
	24	5824	19		77		097
	25	5971	32		99		085
	36	6115	45		0·070 21		073
8	1	6262	58		44		060
	12	6407	71		66		048
	13	6553	84		89		036
	24	6698	97		0·071 11		024
	25	6844	0·189 10		33		012
	36	6989	23		56		000
9	1	7136	36		78		39·988
	12	7280	49	0·000 02	0·072 00	0·000 03	976
	13	7427	62		23		964
	24	7571	75		45		951
	25	7718	88		68		939
	36	7863	0·190 01		90		927
10	1	8009	14		0·073 12		915
	12	8154	27		35		903
	13	8300	40		57		891
	24	8445	53		79		879
	25	8592	66		0·074 02		867
	36	8736	79		24		39·855 40·147
11	1	8883	93		47		135
	12	9027	0·191 06		69		122
	13	9174	19		92		110
	24	9319	32		0·075 14		098
	25	9465	45		36		086
	36	9610	58		59		073
12	1	9756	71		81		061
	12	9901	84		0·076 03		050
	13	50°.0047	98		26		037
	24	0192	0·192 11		48		024

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	25	50°·0339	0·192 24		0 076 71		40·012
	36	0483	37		93		000
13	1	0630	50		0·077 16		39·988
	12	0775	63		38		975
	13	0921	77		60		963
	24	1066	90		83		951
	25	1212	0·193 03		0·078 05		939
	36	1357	16		28		926
14	1	1503	29		50		914
	12	1648	43		72		902
	13	1795	56		95		890
	24	1939	69		0 079 17		877
	25	2086	82	02	40	03	865
	36	2230	96	0·000	62	0·000	39.853 40·149
15	1	2377	0·194 09		85		137
	12	2522	22		0·080 07		124
	13	2668	35		30		112
	24	2813	49		52		099
	25	2959	63		75		087
	36	3104	75		97		074
16	1	3250	89		0·081 20		062
	12	3395	0·195 02		42		050
	13	3542	15		64		037
	24	3686	28		87		025
	25	3833	42		0·082 09		012
	36	3977	55		32		000
17	1	4124	69		54		39·988
	12	4269	82		77		975
	13	4415	95		99		963
	24	4560	0·196 09		0·083 22		950
	25	4706	22		44		940
	36	4851	35		67		925
18	1	4997	49		89		913
	12	5142	62		0·084 12		901
	13	5289	76		34		888
	24	5433	89		56		876

TABLE V—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section and with Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan ϕ	Difference for 10 chains.	Quarter-Section.
	25	50°·5580	0·197 02		0·084 79		863
	36	5724	16		0·085 01		39·851 40 150
19	1	5871	29		24		138
	12	6016	43		46		125
	13	6162	56		69		113
	24	6307	69		91		100
	25	6453	83		0·086 14		088
	36	6598	96		36		075
20	1	6744	0·198 10		59		063
	12	6889	23		81		050
	13	7035	37		0·087 04		038
	24	7180	50		27		025
	25	7327	64		49		013
	36	7471	77		72		000
21	1	7618	91		94		39·987
	12	7762	0·199 04	0·000 02	0·088 17	0·000 03	975
	13	7909	18		39		962
	24	8054	31		62		950
	25	8200	45		84		937
	36	8345	58		0·089 07		925
22	1	8491	72		29		912
	12	8636	85		52		899
	13	8782	99		74		887
	24	8927	0·200 13		97		874
	25	9073	26		0·090 20		862
	36	9218	40		42		39·849 40·152
23	1	9365	53		65		140
	12	9509	67		87		127
	13	9656	81		0·091 10		114
	24	9800	94		32		102
	25	9947	0·201 08		55		089
	36	51°·0091	21		77		076
24	1	0238	35		0·092 00		064
	12	0383	49		22		051
	13	0529	62		45		038

TABLE V—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section and with Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	24	51°·0674	0·201 76		0·092 68		40·025
	25	0820	90		90		013
	36	0965	202 03		093 13		000
25	1	1111	17		35		39·987
	12	1256	31		58		975
	13	1402	44		81		962
	24	1547	58		094 03		949
	25	1694	72		26		936
	36	1838	85		48		924
26	1	1985	99		71		911
	12	2129	203 13		93		898
	13	2276	27		095 16		885
	24	2420	40		39		873
	25	2567	54		61		860
	36	2712	68		84		39·847 40·154
27	1	2858	82	0·000 02	096 07	0·000 03	141
	12	3003	95		29		129
	13	3149	204 09		52		116
	24	3294	23		74		103
	25	3440	37		97		090
	36	3585	51		097 19		077
28	1	3731	64		42		064
	12	3876	78		65		051
	13	4023	92		87		039
	24	4167	205 06		098 10		026
	25	4314	20		33		013
	36	4458	33		55		000
29	1	4605	47		78		39·987
	12	4749	61		099 00		974
	13	4896	75		23		962
	24	5040	89		46		949
	25	5187	206 03		69		936
	36	5332	17		91		923
30	1	5478	31		100 14		910
	12	5623	44		36		897
	13	5769	58		59		884

TABLE V.—*Continued.*

LATITUDE with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	24	51°·5914	0·206 72		0·100 82		39·871
	25	6060	86		101 05		858
	36	6205	207 00		27		39·846 40·156
31	1	6351	14		50		143
	12	6496	28		72		130
	13	6642	42		95		117
	24	6787	56		102 18		104
	25	6934	70		41		091
	36	7078	84		63		078
32	1	7225	99		86		065
	12	7369	208 12		103 08		052
	13	7516	26		31		039
	24	7660	40		54		026
	25	7807	54		77		013
	36	7951	68		99		000
33	1	51°.8098	0·208 82	0·000 02	104 22	0·000 03	39·987
	12	8243	96		45		974
	13	8389	209 10		68		961
	24	8534	24		90		948
	25	8680	38		105 13		935
	36	8825	52		35		922
34	1	8971	66		58		909
	12	9116	80		81		896
	13	9262	94		106 04		883
	24	9407	210 08		26		869
	25	9553	22		49		856
	36	9698	36		72		39·843 40·158
35	1	9844	51		95		145
	12	9989	65		107 17		132
	13	52°.0135	79		40		119
	24	0280	93		63		106
	25	0427	211 07		86		092
	36	0571	21		108 08		079
36	1	0718	36		31		066
	12	0862	50		54		053

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	tude.	Sec. φ	Difference for 10 chains.	Tan. φ	Difference for 10 chains.	Quarter-Section.
	13	1099	64		77		040
	24	1153	78		99		026
	25	1300	92		109 22		013
	36	1444	212 06		45		000
37	1	1591	21		68		39·987
	12	1735	35		90		974
	13	1882	49		110 13		960
	24	2027	63		36		947
	25	2173	77		59		934
	36	2318	92		81		921
38	1	2464	213 06		111 04		907
	12	2609	20		27		894
	13	2755	34		50		881
	24	2900	49		73		867
	25	3046	63		96		855
	36	3191	77		112 18		39·841 40·160
39	1	3337	92	02	41	03	147
	12	3482	214 06		64		134
	13	3628	20	0·000	87	0·000	120
	24	3773	34		113 09		107
	25	3919	49		32		093
	36	4064	63		55		080
40	1	4210	77		78		067
	12	4355	92		114 01		053
	13	4501	215 06		24		040
	24	4646	20		46		027
	25	4794	35		69		013
	36	4937	49		92		000
41	1	52°·5084	0·215 64		0·115 15		39·987
	12	5228	78		38		973
	13	5375	92		61		960
	24	5519	216 07		83		946
	25	5666	21		116 06		933
	36	5810	35		29		920
42	1	5957	50		52		906
	12	6101	64		75		893

TABLE V.—*Continued.*

LATITUDE with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	13	52°·6248	0·216 79		0·116 98		39·879
	24	6392	93		117 21		866
	25	6539	217 08		44		853
	36	6683	22		66		39·839 40·162
43	1	6830	37		89		149
	12	6974	51		118 12		135
	13	7121	66		35		122
	24	7266	80		58		108
	25	7412	95		81		095
	36	7557	218 09		119 04		081
44	1	7703	24		27		068
	12	7848	38		49		054
	13	7994	53		73		041
	24	8139	67		95		027
	25	8285	82		120 18		014
	36	8430	96	02	41	03	000
45	1	8576	219 11	0·000	64	0·000	39·986
	12	8721	25		87		973
	13	8867	40		121 10		950
	24	9012	55		33		946
	25	9158	69		56		932
	36	9303	84		79		919
46	1	9449	98		122 02		905
	12	9594	220 13		25		891
	13	9740	28		48		878
	24	9885	42		70		864
	25	53°·0031	57		93		851
	36	0176	71		123 16		39·837 40·164
47	1	0321	86		39		151
	12	0467	221 01		62		137
	13	0612	15		85		123
	24	0758	30		124 08		110
	25	0903	45		31		096
	36	1049	59		54		082
48	1	1195	74		77		068

TABLE V.—*Continued.*

LATITUDE with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
	12	53°·1340	0·221 89		0·125 00		40·055
	13	1486	222 04		23		041
	24	1631	18		46		027
	25	1777	33		69		014
	36	1922	48		92		000
49	1	2068	63		126 15		39·986
	12	2213	77		38		972
	13	2359	92		61		958
	24	2504	223 07		84		945
	25	2650	22		127 07		931
	36	2795	36		30		917
50	1	2941	51		53		903
	12	3086	66		76		889
	13	3233	81		99		875
	24	3377	96		128 22		861
	25	3524	224 10		45		848
	36	3668	25	0·000 02	68	0·000 03	39·834 40·166
51	1	3815	40		91		153
	12	3959	55	0·000	129 14	0·000	139
	13	4106	70		37		125
	24	4250	85		60		111
	25	4397	225 00		83		097
	36	4541	14		130 06		083
52	1	4688	29		30		069
	12	4832	44		53		055
	13	4979	59		76		042
	24	5123	74		99		028
	25	5270	89		131 23		014
	36	5414	226 04		45		000
53	1	5561	19		68		39·986
	12	5706	34		91		972
	13	5852	49		132 14		958
	24	5996	63		37		944
	25	6143	79		60		930
	36	6287	93		83		917
54	1	6434	227 08		133 07		903

TABLE V.—*Continued.*

LATITUDE with Logarithms of Secant and Tangeant for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. φ	Difference for 10 chains.	Tan. φ	Difference for 10 chains.	Quarter-Section.
	12	53°·6578	0·227 23		0·133 30		39·890
	13	6725	38		53		875
	24	6869	53		76		861
	25	7016	68		99		847
	36	7160	83		134 22		39·833 40·169
55	1	7307	99		45		155
	12	7451	228 13		68		140
	13	7598	29		91		126
	24	7742	44		135 14		112
	25	7889	59		38		098
	36	8033	74		61		084
56	1	8180	89		84		070
	12	8324	229 04		136 07		056
	13	8471	19		30		042
	24	8615	34		53		028
	25	8762	49	02	77	03	014
	36	8906	64		137 00		000
57	1	9052	79	0·900	23	0·000	39·986
	12	9197	95		46		972
	13	9343	230 10		69		958
	24	9488	25		92		944
	25	9634	40		138 16		930
	36	9779	55		39		915
58	1	9925	70		62		901
	12	54°·0070	85		85		887
	13	0216	231 01		139 08		873
	24	0361	16		31		859
	25	0507	31		55		845
	36	0652	46		78		39·831 40·171
59	1	0798	62		140 01		157
	12	0943	77		24		142
	13	1089	92		48		128
	24	1234	232 07		71		114
	25	1380	23		94		100
	36	1525	38		141 17		085

TABLE V.—*Continued.*

LATITUDE with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
60	1	54°·1671	0·232 53		0·141 41		40·071
	12	1816	68		64		057
	13	1962	84		87		043
	24	2107	99		142 10		028
	25	2253	233 14		34		014
	36	2398	29		57		000
61	1	2544	45		80		39·986
	12	2689	60		143 03		971
	13	2835	76		27		957
	24	2980	91		50		943
	25	3126	234 06		73		929
	36	3271	21		96		914
62	1	3417	37		144 20		900
	12	3562	52		43		886
	13	3708	68		66		872
	24	3853	83		89		857
	25	3999	98		145 13		843
	36	4144	235 14	02	36	03	39·829 / 40·173
63	1	4290	29	0·000	59	0·000	159
	12	4435	45		83		144
	13	4581	60		146 06		130
	24	4725	75		29		115
	25	4872	91		53		101
	36	5016	236 06		76		086
64	1	5163	22		99		072
	12	5307	37		147 22		058
	13	5454	53		46		043
	24	5598	68		69		029
	25	5745	84		93		014
	36	5889	99		148 16		000
65	1	6036	0·237 15		0·148 39		39·986
	12	6180	30		63		971
	13	6327	46		86		957
	24	6471	61		149 09		942
	25	6618	77		33		928
	36	6762	92		56		913

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Sections.
66	1	54° 6909	0·238 08		0·149 80		39·899
	12	7053	24		150 03		884
	13	7199	39		26		870
	24	7344	55		50		855
	25	7490	70		73		841
	36	7635	86		96		39·827 40·175
67	1	7781	239 02		151 20		161
	12	7926	17		43		146
	13	8072	33		67		131
	24	8217	49		90		117
	25	8363	64		152 13		102
	36	8508	80		37		088
68	1	8654	96		60		073
	12	8799	240 11		84		058
	13	8945	27		153 07		044
	24	9090	43		31		029
	25	9236	58		54		015
	36	9381	74	02	77	03	000
69	1	9527	90	0·000	154 01	0·000	39·985
	12	9672	241 05		24		971
	13	9818	21		48		956
	24	9962	37		71		941
	25	55° 0109	53		95		927
	36	0253	68		155 18		912
70	1	0400	84		42		898
	12	0544	242 00		65		883
	13	0691	16		89		868
	24	0835	31		156 12		854
	25	0982	47		36		839
	36	1126	63		59		39·824 40·177
71	1	1274	79		83		163
	12	1417	95		157 06		148
	13	1563	243 11		30		133
	24	1708	26		53		118
	25	1854	42		77		104
	36	1999	58		158 00		089

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
72	1	55°·2145	0·243 74		0·158 24		40·074
	12	2290	90		47		059
	13	2436	244 06		71		044
	24	2581	22		94		030
	25	2727	38		159 18		015
	36	2872	53		41		000
73	1	3018	69		65		39·985
	12	3163	85		89		970
	13	3309	245 01		160 12		956
	24	3454	17		36		941
	25	3600	33		59		926
	36	3744	49		83		911
74	1	3891	65		161 07		896
	12	4035	81		30		881
	13	4182	97		54		867
	24	4326	246 13	0·000 02	77	0·000 03	852
	25	4473	29		162 01		837
	36	4617	45		24		39·822 40·180
75	1	4764	61		48		165
	12	4908	77		72		150
	13	5054	93		95		135
	24	5199	247 09		163 19		120
	25	5345	25		43		105
	36	5490	41		66		090
76	1	5636	57		90		075
	12	5781	73		164 13		060
	13	5927	90		37		045
	24	6072	248 06		61		030
	25	6218	22		85		015
	36	6363	38		165 09		000
77	1	6509	54		32		39·985
	12	6654	70		55		970
	13	6800	86		79		955
	24	6944	249 02		166 03		940
	25	7091	19		27		925
	36	7235	35		50		910

TABLE V.—*Continued.*

LATITUDE, with Logarithms of Secant and Tangent for each Section, and width of Quarter-Sections.

Township.	Section.	Latitude.	Sec. ϕ	Difference for 10 chains.	Tan. ϕ	Difference for 10 chains.	Quarter-Section.
78	1	55°·7382	0·249 51		0·166 74		39·895
	12	7526	67		98		880
	13	7672	83		167 21		865
	24	7817	250 00		45		850
	25	7963	16		69		835
	36	8108	32		92		39·820 40·182
79	1	8254	48		168 16		167
	12	8399	64		40		152
	13	8545	81		64		137
	24	8690	97		87		122
	25	8836	251 13		169 11		106
	36	8981	30		35		091
80	1	9127	46	0·000 02	59	0·000 03	076
	12	9272	62		82		061
	13	9418	79		170 06		046
	24	9562	95		30		030
	25	9709	252 11		54		015
	36	9853	27		77		000
81	1	56°·0000	44		171 01		39·985
	12	0144	60		25		970
	13	0291	77		49		954
	24	0435	93		72		939
	25	0581	253 09		96		924
	36	0726	26		172 20		909
82	1	0872	42		44		893
	12	1017	58		68		878
	13	1163	75		92		863
	24	1308	91		173 15		848
	25	1454	254 08		39		833
	36	1599	24		63		39·817 40·185

TABLE VI—For finding the Pole Star.

Hour Angle.	Azimuth.									Distance above or below Pole.	Hour Angle.
	Tp. 0.	Tp. 10.	Tp. 20.	Tp. 30.	Tp. 40.	Tp. 50.	Tp. 60.	Tp. 70.	Tp. 80.		
H.M.											H.M.
0.10	0·09	0·09	0·09	0·09	0·09	0·09	0·09	0·10	0·10	1·32	11.50
0.20	·18	·18	·18	·19	·19	·19	·20	·20	·21	·32	11.30
0.30	·26	·27	·27	·28	·28	·29	·30	·30	·31	·31	11.20
0.40	·35	·36	·36	·37	·38	·38	·39	·40	·41	·30	11.00
0.50	·44	·45	·46	·47	·47	·48	·49	·50	·51	·29	11.10
1.00	·52	·53	·54	·55	·56	·57	·59	·60	·61	·28	11.00
1.10	·61	·62	·63	·64	·65	67	68	·70	·71	·26	10.50
1.20	·69	·70	·71	·73	·74	·75	·77	·79	·81	·24	10.40
1.30	·77	·78	·80	·81	·83	·85	·87	·89	·91	·22	10.30
1.40	·85	·87	·88	90	·92	·94	·96	·98	1·00	·20	10.20
1.50	93	·95	·96	·98	1·00	1·02	1·05	1·07	·09	·17	10.10
2.00	1·01	1·02	1·04	1·06	·08	·11	·13	·16	·18	·14	10.00
2.10	·08	·10	·12	·14	·17	·19	·22	·24	·27	·11	9.50
2.20	·15	·18	·20	·22	·24	·27	·30	·33	·36	·08	9.40
2.30	·22	·25	·27	·30	·32	·35	·38	·41	·44	·05	9.30
2.40	·29	·32	·34	·37	·39	·42	·45	·49	·52	·01	9.20
2.50	·36	·38	·41	·44	·47	50	·53	·56	·60	0·97	9.10
3.00	·42	·45	·48	·50	·53	·57	·60	·64	·67	·93	9.00
3.10	·48	·51	·54	·57	·60	·63	·67	·70	·74	·89	8.50
3.20	·54	·57	·60	·63	·66	·70	·73	·77	·81	·85	8.40
3.30	·60	·63	·66	·69	·72	·76	·80	·84	·88	·80	8.30
3.40	·65	·68	·71	·74	·78	·81	·85	·89	·94	·76	8.20
3.50	·70	·73	·76	·79	·83	·87	·91	·95	·99	·71	8.10
4.00	·74	·77	·81	·84	·88	·92	·96	2·00	2·05	·66	8.00
4.10	·78	·82	·85	·89	·92	·96	2·01	·05	·10	·61	7.50
4.20	·82	·86	·89	·93	·97	2·01	·05	·10	·14	·56	7.40
4.30	·86	·89	·93	·97	2·01	05	·09	·14	·19	·51	7.30
4.40	·89	·92	·96	2·00	·04	·08	·13	·17	·22	·45	7.20
4.50	·92	·95	·99	·03	·07	·11	·16	·21	·26	·40	7.10
5.00	·94	·98	2·02	·06	·10	·14	·19	23	·28	·34	7.00
5.10	·98	2·00	·04	·08	·12	·16	·21	·26	·31	·29	6.50
5.20	·98	·02	·06	·10	·14	·18	·23	·28	·33	·23	6.40
5.30	2·00	·03	·07	·11	·15	·20	·24	·29	·35	·17	6.30
5.40	·01	·04	·08	·12	·16	·21	·25	·30	·36	·12	6.20
5.50	·01	·05	·09	·13	·17	·21	·26	·31	·36	·06	6.10
6.00	·01	·05	·09	·13	·17	·21	·26	·31	·37	·00	6.00

TABLE VII.—For finding the Time

t^d		Declination 0°	5°	10°	15°	20°	25°	30°
H.	M.							
0 or 12	10	1·13925	1·14019	1·14114	1·14176	1·14301	1·14395	1·14489
	20	·43996	·44091	·44170	·44264	·44358	·44451	·44560
	30	·61542	·61627	·61721	·61805	61899	·62003	·62107
	40	·73933	·74020	·74107	·74194	·74288	·74390	·74500
	50	·83506	·83588	·83677	·83765	·83860	·83954	·84067
1 or 13	00	1·91270	1·91355	1·91440	1·91529	1·91619	1·91719	1·91824
	10	·97782	·97864	·97950	·98046	·98127	·98223	·98327
	20	2·03375	2·03455	2·03539	2·03627	2·03715	2.03810	2·03914
	30	·08254	·08332	·08415	·08500	·08586	·08682	·08782
	40	·12564	·12643	·12723	·12808	·12892	·12985	·13085
	50	·16412	·16489	·16566	·16649	·16732	·16823	·16921
2 or 14	00	2·19866	2·19943	2·20016	2·20096	2·20181	2·20268	2·20363
	10	·22991	·23065	·23139	·23215	·23297	·23381	·23475
	20	·25828	·25900	·25971	·26045	·26124	·26207	·26298
	30	·28414	·28484	·28554	·28625	·28702	·28782	·28868
	40	·30775	·30841	·30910	·30980	·31052	·31131	·31214
	50	·32938	·33003	·33068	·33135	·33205	·33280	·33361
3 or 15	00	2·34918	2·34980	2·35042	2·35106	2·35174	2·35247	2·35324
	10	·36732	·36791	·36851	·36912	·36977	·37046	·37120
	20	·38394	·38449	·38507	·38566	·38627	·38693	·38762
	30	·39915	·39969	·40023	·40078	·40137	·40199	·40264
	40	·41306	·41357	·41407	·41459	·41514	·41572	·41636
	50	·42572	·42619	·42665	·42714	·42767	·42820	·42880
4 or 16	00	2·43722	2·43767	2·43810	2·43856	2·43905	2·43955	2·44010
	10	·44762	·44803	·44843	·44886	·44929	·44977	·45028
	20	·45697	·45734	·45772	·45818	·45850	·45894	·45941
	30	·46529	·46562	·46597	·46634	·46668	·46708	·46749
	40	·47263	·47297	·47328	·47360	·47392	·47428	·47465
	50	·47911	·47937	·47965	·47995	·48021	·48051	·48084
5 or 17	00	2·48462	2·48486	2·48508	2·48533	2·48557	2·48583	2·48612
	10	·48927	·48946	·48966	·48985	·49006	·49028	·49052
	20	·49304	·49319	·49335	·49350	·49367	·49385	·49405
	30	·49596	·49607	·49620	·49631	·49643	·49657	·49671
	40	·49803	·49811	·49818	·49827	·49835	·49844	·49853
	50	·49927	·49931	·49935	·49938	·49944	·49948	·49952
6 or 18	00	2·49969	2·49969	2·49969	2·49969	2·49969	2·49969	2·49969
	10	·49927	·49923	·49919	·49917	·49911	·49907	·49903
	20	·49803	·49795	·49789	·49780	·49772	·49763	·49754
	30	·49596	·49585	·49572	·49561	·49549	·49535	·49521
	40	·49304	·49289	·49273	·49258	·49241	·49223	·49203
	50	·48927	·48908	·48889	·48869	·48848	·48826	·48802
		0°	5°	10°	15°	20°	25°	30°
		Declination						

by Transits across the vertical of Polaris.

North.

35°	40°	45°	50°	55°	60°	H.	H.	M.
1·14613	1·14768	1·14922	1·15106	1·15320	1·15625	11 or 23		50
·44685	·44824	·44979	·45163	·45393	·45682			40
·62232	·62366	·62521	·62706	·62931	·63225			30
·74617	·74749	·74904	·75089	·75312	·75603			20
·84180	·84317	·84466	·84652	·84874	·85163			10
1·91939	1.92070	1·92226	1·92402	1·92624	1·92906	11 or 23		00
·98444	·98574	·98722	·98900	·99118	·99401	10 or 22		50
2·04025	2·04155	2·04301	2·04477	2·04693	2·04969			40
·08895	·09019	·09167	·09339	·09552	·09823			30
·13194	·13316	·13459	·13628	·13836	·14101			20
·17026	·17149	·17286	·17452	·17658	·17918			10
2·20466	2·20586	2·20721	2·20884	2·21082	2·21338	10 or 22		00
·23575	·23697	·23825	·23982	·24178	·24425	9 or 21		50
·26397	·26507	·26637	·26793	·26980	·27221			40
·28966	·29072	·29199	·29347	·29531	·29763			30
·31306	·31412	·31534	·31677	·31854	·32079			20
·33449	·33552	·33668	·33806	·33977	·34193			10
2·35409	2·35507	2·35618	2·35751	2·35916	2·36124	9 or 21		00
·37201	·37295	·37401	·37528	·37685	·37883	8 or 20		50
·38841	·38929	·39032	·39151	·39301	·39491			40
·40339	·40422	·40520	·40634	·40775	·40955			30
·41706	·41783	·41875	·41984	·42116	·42287			20
·42945	·43022	·43104	·43206	·43331	·43491			10
2·44070	2·44140	2·44218	2·44314	2·44430	2·44579	8 or 20		00
·45083	·45148	·45220	·45307	·45415	·45553	7 or 19		50
·45992	·46050	·46117	·46197	·46295	·46421			40
·46796	·46849	·46911	·46982	·47071	·47186			30
·47506	·47554	·47608	·47673	·47753	·47856			20
·48122	·48163	·48210	·48267	·48337	·48429			10
2·48643	2·48678	2·48721	2·48769	2·48830	2·48907	7 or 19		00
·49077	·49108	·49142	·49184	·49234	·49300	6 or 18		50
·49425	·49449	·49477	·49510	·49550	·49603			40
·49687	·49706	·49726	·49751	·49782	·49821			30
·49864	·49876	·49890	·49907	·49927	·49954			20
·49958	·49965	·49972	·49979	·49989	·50003			10
2·49969	2·49969	2·49969	2·49969	2·49969	2·49969	6 or 18		00
·49897	·49890	·49883	·49875	·49865	·49852	5 or 17		50
·49742	·49730	·49717	·49700	·49679	·49652			40
·49505	·49486	·49465	·49440	·49410	·49370			30
·49182	·49158	·49130	·49097	·49056	·49003			20
·48776	·48745	·48711	·48668	·48618	·48551			10
35°	40°	45°	50°	55°	60°			

South.

t-t'

TABLE VII.—For finding the Time by Transits

-t'		Declination						
		0°	5°	10°	15°	20°	25°	30°
H. H.	M.							
7 or 19	00	2·48462	2·48440	2·48417	2·48393	2·48369	2·48341	2·48313
	10	·47911	·47885	·47858	·47828	·47802	·47771	·47738
	20	·47268	·47239	·47208	·47176	·47144	·47108	·47070
	30	·46529	·46497	·46463	·46426	·46390	·46351	·46309
	40	·45697	·45661	·45623	·45583	·45543	·45500	·45452
	50	·44762	·44722	·44682	·44638	·44595	·44546	·44495
8 or 20	00	2·43722	2·43678	2·43635	2·43589	2·43540	2·43489	2·43433
	10	·42572	·42524	·42477	·42428	·42376	·42322	·42261
	20	·41306	·41256	·41207	·41154	·41098	·41039	·40974
	30	·39915	·39861	·39808	·39752	·39693	·39630	·39564
	40	·38394	·38339	·38281	·38222	·38161	·38093	·38023
	50	·36732	·36672	·36613	·36551	·36485	·36416	·36340
9 or 21	00	2·34918	2·34856	2·34794	2·34729	2·34661	2·34587	2·34508
	10	·32938	·32873	·32807	·32746	·32669	·32593	·32510
	20	·30775	·30709	·30641	·30570	·30496	·30417	·30333
	30	·28414	·28344	·28274	·28201	·28124	·28042	·27955
	40	·25828	·25756	·25684	·25610	·25529	·25445	·25353
	50	·22991	·22917	·22843	·22766	·22683	·22598	·22502
10 or 22	00	2·19866	2·19789	2·19714	2·19634	2·19549	2·19459	2·19367
	10	·16412	·16334	·16256	·16173	·16089	·15996	·15897
	20	·12564	·12486	·12405	·12320	·12235	·12139	·12037
	30	·08254	·08175	·08092	·08005	·07918	·07820	·07718
	40	2·03375	2·03294	2·03209	2·03121	2·03032	2·02934	2·02829
	50	1·97782	1·97699	1·97612	1·97516	1·97433	1·97336	1·97230
11 or 23	00	1·91270	1·91185	1·91100	1·91009	1·90918	1·90816	1·90709
	10	·83506	·83423	·83334	·83245	·83149	·83046	·82937
	20	·73933	·73846	·73759	·73672	·73576	·73472	·73360
	30	·61542	·61458	·61363	·61278	·61183	·61077	·60970
	40	·43996	·43902	·43823	·43727	·43632	·43537	·43425
	50	·13925	·13830	·13735	·13672	·13545	·13450	·13354
		0°	5°	10°	15°	20°	25°	30°
		Declination						

across the vertical of Polaris—*Concluded.*

North.						
35°	40°	45°	50°	55°	60°	H. H. M.
2·48281	2·48245	2·48203	2·48154	2·48093	2·48014	5 or 17 00
·47701	·47659	·47611	·47553	·47481	·47388	4 or 16 50
·47029	·46981	·46926	·46860	·46779	·46673	40
·46261	·46209	·46146	·46072	·45980	·45862	30
·45400	·45342	·45274	·45192	·45091	·44961	20
·44439	·44373	·44300	·44211	·44099	·43957	10
2·43372	2·43302	2·43222	2·43123	2·43005	2·42849	4 or 16 00
·42195	·42116	·42032	·41927	·41799	·41633	3 or 15 50
·40904	·40824	·40730	·40618	·40481	·40303	40
·39487	·39403	·39303	·39185	·39039	·38851	30
·37944	·37853	·37747	·37623	·37468	·37269	20
·36257	·36162	·36051	·35921	·35757	·35549	10
2·34422	2·34321	2·34207	2·34068	2·33897	2·33678	3 or 15 00
·32420	·32315	·32195	·32052	·31873	·31645	2 or 14 50
·30237	·30129	·30003	·29855	·29669	·29432	40
·27854	·27745	·27614	·27460	·27268	·27021	30
·25251	·25137	·25003	·24841	·24645	·24388	20
·22398	·22275	·22141	·21977	·21772	·21508	10
2·19257	2·19134	2·18994	2·18822	2·18614	2·18341	2 or 14 00
·15788	·15661	·15518	·15345	·15128	·14851	1 or 13 50
·11926	·11800	·11651	·11474	·11254	·10972	40
·07602	·07475	·07320	·07140	·06915	·06625	30
2·02715	2·02580	2·02428	2·02243	2·02015	2·01720	20
1·97109	1·96974	1·96820	1·96633	1·96402	1·96099	10
1·90590	1·90455	1·90293	1·90108	1·89873	1·89570	1 or 13 00
·82821	·82679	·82523	·82393	·82092	·81783	0 or 12 50
·73239	·73102	·72941	·72746	·72509	·72198	40
·60842	·60703	·60541	·60347	·60108	·59791	30
·43297	·43152	·42991	·42797	·42553	·42243	20
·13226	·13066	·12905	·12710	·12483	·12156	10
35°	40°	45°	50°	55°	60°	
South.						$t-t'$

TABLE VIII.

For Converting Chains into Decimals of a Township side.

Chains.	Equivalent decimal of a Township side.		Chains.	Equivalent decimal of a Township side.		Chains.	Equivalent decimal of a Township side.	
	N. or S. side.	E. or W. side.		N. or S. side.	E. or W. side.		N. or S. side.	E. or W. side.
1	·00206	·00207	9	·01852	·01863	70	·14403	·14493
2	·00412	·00414				80	·16461	·16563
3	·00617	·00621	10	·02058	·02070	90	·18518	·18634
4	·00823	·00828	20	·04115	·04141			
			30	·06173	·06211	100	·20576	·20704
5	·01029	·01035	40	·08230	·08282	200	·41152	·41408
6	·01235	·01242				300	·61728	·62112
7	·01440	·01449	50	·10288	·10352	400	·82304	·82816
8	·01646	·01656	60	·12346	·12422			

TABLE IX.

Correction to width of Road Allowance on Correction Lines.

Jog in Chains.	Number of Correction Line.				Jog in Chains.	Number of Correction Line.			
	1	11	21	31		1	11	21	31
10	0·9	1·0	1·1	1·3	70	5·3	6·0	6·8	7·8
20	1·7	1·9	2·2	2·5	80	5·9	6·7	7·6	8·7
30	2·5	2·8	3·2	3·7	90	6·5	7·3	8·4	9·5
40	3·3	3·7	4·2	4·8	100	7·0	8·0	9·0	10·3
50	4·0	4·5	5·1	5·8	110	7·5	8·5	9·7	11·1
60	4·7	5·3	6·0	6·8	120	8·0	9·1	10·3	11·8

For Converting the Logarithm Tangent of Small Arcs into Logarithm of Seconds of Arc.

Log. tan.	Log. T.	Log. tan.	Log. T.	Log. tan.	Log. T.
7·920	5.314 42	8·419	5·314 33	8·547	5·314 25
8·071	41	·440	32	·558	24
·157	40	·459	31	·570	23
·221	39	·477	30	·581	22
·269	38	·493	29	·591	21
·309	37	·508	28	·601	20
·342	36	·521	27	·610	19
·371	35	·535	26	·619	18
·396	34				

Showing the Deflection of a Trial Line for Deviations from 1 to 149 links at the end of eighty-one chains.

Links.	Decimal Division.	Sexagesimal Division.		Links.	Decimal Division.	Sexagesimal Division.		Links.	Decimal Division.	Sexagesimal Division.		Links.	Decimal Division.	Sexagesimal Division.	
	°	′	″		°	′	″		°	′	″		°	′	″
0	0·000	0	00	40	·283		59	80	·566		57	120	0·849	50	55
1	·007		25	41	·290	17	24	81	·573	34	23	121	·856	51	21
2	·014		51	42	·297		50	82	·580		48	122	·863		46
3	·021	1	16	43	·304	18	15	83	·587	35	13	123	·870	52	12
4	·028		42	44	·311		41	84	·594		39	124	·877		37
5	·035	2	07	45	·318	19	06	85	·601	36	04	125	·884	53	03
6	·042		33	46	·325		31	86	·608		30	126	·891		28
7	·050		58	47	·332		57	87	·615		55	127	·898		54
8	·057	3	24	48	·340	20	22	88	·622	37	21	128	·905	54	19
9	·064		49	49	·347		48	89	·630		46	129	·912		45
10	·071	4	15	50	·354	21	13	90	0·637	38	12	130	·919	55	10
11	·078		40	51	·361		39	91	·644		37	131	·927		35
12	·085	5	06	52	·368	22	04	92	·651	39	03	132	·934	56	01
13	·092		31	53	·375		30	93	·658		28	133	·941		26
14	·099		57	54	·382		55	94	·665		54	134	·948		52
15	·106	6	22	55	·389	23	21	95	·672	40	19	135	·955	57	17
16	·113		47	56	·396		46	96	·679		44	136	·962		43
17	·120	7	13	57	·403	24	12	97	·686	41	10	137	·969	58	08
18	·127		38	58	·410		37	98	·693		35	138	·976		34
19	·134	8	03	59	·417	25	02	99	·700	42	01	139	·983		59
20	·141		29	60	0·424	25	28	100	·707		26	140	·990	59	25
21	·149		55	61	·432		53	101	·714		52	141	·997		50
22	·156	9	20	62	·439	26	19	102	·721	43	17	142	1·004	60	16
23	·163		46	63	·446		44	103	·729		43	143	·011		41
24	·170	10	11	64	·453	27	10	104	·736	44	08	144	·018	61	06
25	·177		37	65	·460		35	105	·743		34	145	·026		33
26	·184	11	02	66	·467	28	01	106	·750		59	146	·033		57
27	·191		28	67	·474		26	107	·757	45	24	147	·040	62	23
28	·198		53	68	·481		52	108	·764		50	148	·047		48
29	·205	12	19	69	·488	29	17	109	·771	46	15	149	·054	63	39
30	0·212	12	44	70	·495		43	110	·778		41				
31	·219	13	09	71	·502	30	08	111	·785	47	06				
32	·226		35	72	·509		33	112	·792		32				
33	·233	14	00	73	·516		59	113	·799		57				
34	·241		26	74	·523	31	24	114	·806	48	23				
35	·248		51	75	·531		50	115	·813		48				
36	·255	15	17	76	·538	32	15	116	·820	49	14				
37	·262		42	77	·545		41	117	·828		39				
38	·269	16	08	78	·552	33	06	118	·835	50	05				
39	·276		33	79	·559		32	119	·842		30				

Addition and Subtraction Logarithms.

A.	0	1	2	3	4	5	6	7	8	9	A.
5·0	B0·0 0000	0001	0001	0001	0001	0001	0002	0002	0003	0003	5·0
6·0	0·0 0004	0004	0005	0005	0005	0005	0005	0005	0005	0005	6·0
1	0005	0006	0006	0006	0006	0006	0006	0006	0007	0007	1
2	0007	0007	0007	0007	0008	0008	0008	0008	0008	0008	2
3	0009	0009	0009	0009	0010	0010	0010	0010	0010	0011	3
4	0011	0011	0011	0012	0012	0012	0013	0013	0013	0013	4
5	0014	0014	0014	0015	0015	0015	0016	0016	0017	0017	5
6	0017	0018	0018	0019	0019	0019	0020	0020	0021	0021	6
7	0022	0022	0023	0023	0024	0024	0025	0026	0026	0027	7
8	0027	0028	0029	0029	0030	0031	0031	0032	0033	0034	8
9	0034	0035	0036	0037	0038	0039	0040	0041	0041	0042	9
7·0	0·0 0043	0044	0045	0047	0048	0049	0050	0051	0052	0053	7·0
1	0055	0056	0057	0059	0060	0061	0063	0064	0066	0067	1
2	0069	0070	0072	0074	0075	0077	0079	0081	0083	0085	2
3	0087	0089	0091	0093	0095	0097	0099	0102	0104	0106	3
4	0109	0111	0114	0117	0119	0122	0125	0128	0131	0134	4
5	0137	0140	0144	0147	0150	0154	0157	0161	0165	0169	5
6	0173	0177	0181	0185	0189	0194	0198	0203	0207	0212	6
7	0217	0222	0227	0233	0238	0244	0249	0255	0261	0267	7
8	0273	0280	0286	0293	0299	0306	0313	0321	0328	0336	8
9	0344	0352	0360	0368	0377	0385	0394	0403	0413	0422	9
8·00	0·0 0432	0433	0434	0435	0436	0437	0438	0439	0440	0441	8·00
01	0442	0443	0444	0445	0446	0447	0448	0449	0450	0451	01
02	0452	0453	0454	0456	0457	0458	0459	0460	0461	0462	02
03	0463	0464	0465	0466	0467	0468	0469	0470	0471	0473	03
04	0474	0475	0476	0477	0478	0479	0480	0481	0482	0483	04
05	0485	0486	0487	0488	0489	0490	0491	0492	0494	0495	05
06	0496	0497	0498	0499	0500	0502	0503	0504	0505	0506	06
07	0507	0508	0510	0511	0512	0513	0514	0515	0517	0518	07
08	0519	0520	0521	0523	0524	0525	0526	0527	0529	0530	08
09	0531	0532	0533	0535	0536	0537	0538	0540	0541	0542	09
8·10	0·0 0543	0545	0546	0547	0548	0550	0551	0552	0553	0555	8·10
11	0556	0557	0558	0560	0561	0562	0564	0565	0566	0567	11
12	0569	0570	0571	0573	0574	0575	0577	0578	0579	0581	12
13	0582	0583	0585	0586	0587	0589	0590	0591	0593	0594	13
14	0595	0597	0598	0599	0601	0602	0604	0605	0606	0608	14
15	0609	0611	0612	0613	0615	0616	0618	0619	0620	0622	15
16	0623	0625	0626	0628	0629	0630	0632	0633	0635	0636	16
17	0638	0639	0641	0642	0644	0645	0646	0648	0649	0651	17
18	0652	0654	0655	0657	0658	0660	0661	0663	0664	0666	18
19	0667	0669	0671	0672	0674	0675	0677	0678	0680	0681	19

Addition and Subtraction Logarithms.

A.	0	1	2	3	4	5	6	7	8	9	A.
8·20	0·0 0683	0684	0686	0688	0689	0691	0692	0694	0696	0697	8·20
21	0699	0700	0702	0703	0705	0707	0708	0710	0712	0713	21
22	0715	0716	0718	0720	0721	0723	0725	0726	0728	0730	22
23	0731	0733	0735	0736	0738	0740	0741	0743	0745	0747	23
24	0748	0750	0752	0753	0755	0757	0759	0760	0762	0764	24
25	0766	0767	0769	0771	0773	0774	0776	0778	0780	0781	25
26	0783	0785	0787	0789	0790	0792	0794	0796	0798	0799	26
27	0801	0803	0805	0807	0809	0810	0812	0814	0816	0818	27
28	0820	0822	0823	0825	0827	0829	0831	0833	0835	0837	28
29	0839	0841	0842	0844	0846	0848	0850	0852	0854	0856	29
8·30	B0·0 0858	0860	0862	0864	0866	0868	0870	0872	0874	0876	8·30
31	0878	0880	0882	0884	0886	0888	0890	0892	0894	0896	31
32	0898	0900	0902	0904	0906	0908	0910	0912	0915	0917	32
33	0919	0921	0923	0925	0927	0929	0931	0933	0936	0938	33
34	0940	0942	0944	0946	0948	0951	0953	0955	0957	0959	34
35	0962	0964	0966	0968	0970	0973	0975	0977	0979	0981	35
36	0984	0986	0988	0990	0993	0995	0997	0999	1002	1004	36
37	1006	1009	1011	1013	1016	1018	1020	1022	1025	1027	37
38	1030	1032	1034	1037	1039	1041	1044	1046	1048	1051	38
39	1053	1056	1058	1060	1063	1065	1068	1070	1073	1075	39
8·40	0·0 1077	1080	1082	1085	1087	1090	1092	1095	1097	1100	8·40
41	1102	1105	1107	1110	1112	1115	1117	1120	1122	1125	41
42	1128	1130	1133	1135	1138	1140	1143	1146	1148	1151	42
43	1153	1156	1159	1161	1164	1167	1169	1172	1175	1177	43
44	1180	1183	1185	1188	1191	1193	1196	1199	1202	1204	44
45	1207	1210	1213	1215	1218	1221	1224	1226	1229	1232	45
46	1235	1238	1240	1243	1246	1249	1252	1255	1257	1260	46
47	1263	1266	1269	1272	1275	1278	1280	1283	1286	1289	47
48	1292	1295	1298	1301	1304	1307	1310	1313	1316	1319	48
49	1322	1325	1328	1331	1334	1337	1340	1343	1346	1349	49
8·50	0 0 1352	1355	1358	1361	1364	1368	1371	1374	1377	1380	8·50
51	1383	1386	1389	1393	1396	1399	1402	1405	1408	1412	51
52	1415	1418	1421	1424	1428	1431	1434	1437	1441	1444	52
53	1447	1450	1454	1457	1460	1464	1467	1470	1474	1477	53
54	1480	1484	1487	1490	1494	1497	1501	1504	1507	1511	54
55	1514	1518	1521	1525	1528	1531	1535	1538	1542	1545	55
56	1549	1552	1556	1559	1563	1566	1570	1574	1577	1581	56
57	1584	1588	1591	1595	1599	1602	1606	1610	1613	1617	57
58	1621	1624	1628	1632	1635	1639	1643	1646	1650	1654	58
59	1658	1661	1665	1669	1673	1676	1680	1684	1688	1692	59
8·60	0·0 1695	1699	1703	1707	1711	1715	1719	1722	1726	1730	8·60

Latitude 50°.

Apparent Time, P.M.	Declination North.						Declination South.					Apparent Time, A.M.
	25°	20°	15°	10°	5°	0°	5°	10°	15°	20°	25°	
H. M.												H. M.
0.00	0·4	0·5	0·7	0·8	1·0	1·1	1·4	1·6	2·0	2·6	3·5	12.00
1.00	0·5	0·6	0·7	0·8	1·0	1·2	1·4	1·7	2·1	2·8	3·8	11.00
2.00	0·5	0·7	0 8	0·9	1·1	1·3	1·6	1·9	2·5	3·3	4·9	10.00
2.30	0·6	0·7	0·8	1·0	1·2	1·4	1·7	2·2	2·8	3·9	6·2	9.30
3.00	0·6	0·8	0·9	1·1	1·3	1·6	2·0	2·5	3·3	5·0	.....	9.00
3.30	0·7	0·9	1·1	1·3	1·5	1·9	2·3	3·1	4·5	7·7	.....	8.30
4.00	0·9	1·0	1·2	1·5	1·8	2·3	3·0	4·2	7·0	.....	.....	8.00
4.30	1·0	1·2	1·5	1·8	2·3	3·0	4·2	6·9	.....	.....	.....	7.30
5.00	1·2	1·5	1·8	2·3	3·1	4·4	7·5	.....	.....	.....	.....	7.00
5.30	1·6	1·9	2·4	3·3	4·8	8·7	.....	.....	.....	.....	.....	6.30
6.00	2·0	2·6	3·5	5·4	.....	.....	.....	.....	.....	.....	.....	6.00
6.30	2·8	3·9	6·2	.....	.....	.....	.....	.....	.....	.....	.....	5.30

Latitude 53°.

0.00	0·5	0·6	0·7	0·9	1·1	1·3	1·5	1·9	2·4	3·1	4·5	12.00
1.00	0·5	0·6	0·8	0·9	1·1	1·3	1·6	2·0	2·5	3·3	4·9	11.00
2.00	0·6	0·7	0·9	1·0	1·2	1·5	1·8	2·2	2·9	4·1	6·7	10.00
2.30	0·6	0·8	0·9	1·1	1·3	1·6	2·0	2·5	3·3	5·0	9·3	9.30
3.00	0·7	0·9	1·0	1·2	1·5	1·8	2·2	2·9	4·1	6·7	.....	9.00
3.30	0·8	1·0	1·1	1·4	1·7	2·1	2·7	3·6	5·6	.....	.....	8.30
4.00	1·0	1·1	1·3	1·6	2·0	2·5	3·4	5·1	9·6	.....	.....	8.00
4.30	1·1	1·3	1·6	1·9	2·5	3·3	4·9	9·0	.....	.....	.....	7.30
5.00	1·3	1·6	1·9	2·5	3·3	4·9	9·0	.....	.....	.....	.....	7.00
5.30	1·6	1·9	2·5	3·4	5·1	9·7	.....	.....	.....	.....	.....	6.30
6.00	2·0	2·6	3·6	5·4	.....	.....	.....	.....	.....	.....	.....	6.00
6.30	2·7	3·5	5·2	.....	.....	.....	.....	.....	.....	.....	.....	5.30